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GEOGRAPHICAL REVIEW

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OUR CONTRIBUTORS

Professor Hobbs is professor of geology in the University of Michigan. In the broad sphere of his interests special mention may be made of his work in seismology and glaciology, and, in connection with the latter, certain aspects of meteorology. His writings include "Earthquakes" (1907); "Characteristics of Existing Glaciers" (1911); "Earth Evolution and Its Facial Expression" (1921); "Cruises Along By-ways of the Pacific" (1925); "The Glacial Anticyclones" (1926). To the *Geographical Review* he contributed a paper on his journey to northeast Africa for the study of desert conditions (Vol. 3, 1917).

Major Holstein is connected with American business interests in Peru. He has been on service in the Philippines, China, and Mexico, and took part in the World War. He is president of the recently formed archeological society of Trujillo, which is now engaged in making a plan of the ruins of Chan-Chan. Major Holstein is also carrying on meteorological observations for the American Geographical Society.

Mr. Sykes has for many years been associated with the Desert Laboratory of the Carnegie Institution, Tucson, Arizona. He has intimate knowledge of the arid southwestern United States in both physical and historical phases, and he has made comparative studies in the Libyan Desert (*Bull. Amer. Geogr. Soc.*, Vol. 44, 1912). His studies in historical cartography include the papers "The Mythical Straits of Anian" and "The Isles of California" in the *Bulletin of the American Geographical Society* (Vol. 47, 1915). To the *Geographical Review* he contributed "The Delta and Estuary of the Colorado River" (Vol. 16, 1926).

Mlle. Choveaux, whose untimely death occurred on July 3, 1926, is described by Professor Brunhes as one of his most brilliant pupils. She had been acting as assistant in the Institut de Géographie at the Sorbonne and had already written several scholarly papers, including "L'influence des engrais Marins sur les rives du golfe du Morbihan" and "La Forest of Dean," which were published in the *Annales de Géographie* in 1920 and 1922 respectively. She took part in the International Geographical Congress at Cairo in 1925, from whence she visited Palestine collecting data for the article here published.

Mrs. Jollie has traveled extensively and for long has had affiliations in Southern Rhodesia. She was Honorary Secretary and Organizer of the Responsible Government Party in S. Rhodesia, 1920, and is a member of the Legislative Council of Southern Rhodesia, the first woman to be elected to any British Colonial Legislature. Her writings include "The Real Rhodesia" (1924).

Professor Hermannsson, a native of Iceland, is Curator of the Fiske Icelandic Collection, Professor of Scandinavian Languages and Literatures in Cornell University, and author of numerous works on Icelandic literature.

Commander Patton is Chief of the Division of Charts of the U. S. Coast and Geodetic Survey. He is the author of "Yakutat Bay to Arctic Ocean" (*U. S. Coast Pilot, Alaska*, 1916) and "California, Oregon and Washington" (*U. S. Coast Pilot, Pacific Ocean*, 1917). He is Chairman of the National Research Council Committee on Shoreline Investigations and Secretary of the Executive Committee for study of coast erosion and protection appointed at the Asbury Park meeting (see Professor Johnson's paper in this number of the *Review*).

Professor Johnson is professor of physiography in Columbia University. In addition to numerous physiographic papers he has written "Shore Processes and Shoreline Development" (1919) and "The New England-Acadian Shoreline" (1925). He has made a special study of the influence of physiography in the conduct of military operations. "Topography and Strategy" was published in 1917 and "Battlefields of the World War" in 1921 as No. 3 of the American Geographical Society's Research Series.

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Map of Hispanic America, 1:1,000,000 [15.78 miles to 1 inch], Provisional Edition, Sheet South E–19, LA PAZ, 1922. Sheet South C–19, ACRE, 1924. Sheet North G–12, BAJA CALIFORNIA-SUR, 1924. $2.00 each sheet.

Map of Hispanic America, 1:6,000,000 [about 100 miles to 1 inch], compiled from nearly 250 sources and showing railways, drainage, international and administrative boundaries, and towns in graded sequence down to those with a population of 4000. Produced in black in three sheets—measurements of 2 (to border) are 34 x 28 inches, and of the third 32¼ x 30 inches. 1922. $5.00.

Mapa de la Republica de Panama, 1:500,000 [7.89 miles to 1 inch] compiled from over 100 original surveys, many of them unpublished. Printed in five colors. Shows drainage, relief by contours, cities and towns graded according to population and administrative importance, railways classified according to gauge, motor roads, wagon roads, and trails. Follows in general the scheme of the International Map of the World on the Millionth Scale, but hypsometric tints have been omitted and the provinces shown in color instead. Spanish throughout, including title and legend. Accepted as official map by the government of Panama. 33 x 63 inches. 1926. $3.00.

Separate Maps published in the *Geographical Review* and the *Bulletin of the American Geographical Society*, the majority in color. 25 cents each. A list will be sent upon request.

THE
GEOGRAPHICAL REVIEW

VOL. XVII JANUARY, 1927 NO. 1

THE FIRST GREENLAND EXPEDITION OF THE UNIVERSITY OF MICHIGAN

William Herbert Hobbs
University of Michigan

[With Figs. 20, 21, and 22 on Pl. I facing p. 14]

THE First Greenland Expedition of the University of Michigan returned in late September after a successful season's work in the field. The expedition was of a reconnaissance nature, preliminary to the larger effort planned for 1927.[1] The journey both to and from Greenland was made on the *Morrissey*, chartered by Mr. George Palmer Putnam, the Director of the Greenland Expedition of the American Museum of Natural History, and with Captain Robert A. Bartlett as skipper. The *Morrissey* sailed from North Sydney, Nova Scotia, on June 27 and arrived in Holstensborg on July 6. On the return she left Holstensborg on September 7 and reached North Sydney September 23.

Holstensborg numbers some two hundred souls including two European families, those of the Danish officials. The little settlement is situated upon a series of coastal terraces cut in the hard crystalline rock on the borders of a natural landlocked harbor which is one of the best in Greenland (Fig. 2). It is quite hidden from the sea but may be found from the location of the high Kaerlingerhaetten (2470 feet), which lies immediately north and is so named from its supposed resemblance to the peculiar topknot which is commonly worn by the old women in Greenland. This mountain appears in the background of Figure 22.

As was pointed out by Nordenskjöld, this district of Greenland enjoys a more favorable climate than its neighbors and is

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[1] W. H. Hobbs: The University of Michigan Greenland Expedition of 1926–1927, *Geogr. Rev.*, Vol. 16, 1926, pp. 256–263.

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unusually dry and warm with clear skies.[2] It is also favored above its sister settlements by the importance of the halibut and cod banks in its vicinity. These fishing grounds have long attracted vessels from various other nations as well as from Denmark, but in 1924 a new local industry was developed at Holstensborg—a cannery for halibut and cod equipped with modern machinery.

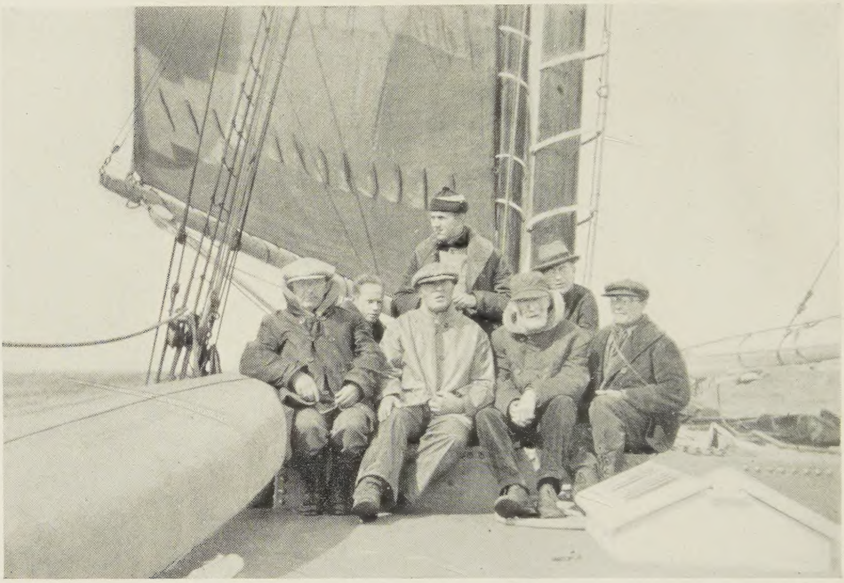

FIG. 1—The members of the University of Michigan Greenland Expedition en route to Greenland on the schooner *Morrissey*, Captain Robert A. Bartlett, Master. Left to right in front row: Fergusson, Bartlett, Hobbs, Church; back row: Belknap, Gould, Oscanyan. (Photograph by H. C. Raven.)

SELECTION OF DISTRICT AND MAIN BASE

The area chosen for exploration by the Michigan Expedition lies within the widest part of the coast-land ribbon which surrounds the inland ice of Greenland. The district of Holstensborg includes a large hinterland representing a greater blank upon the Danish official map than is elsewhere to be found upon the west coast (Fig. 2). The inland ice, which it was our purpose to study, is within this district more remote and difficult of access than elsewhere; but it was believed that once it had been reached access to the interior would be found to be on easier grades than is usual. There was also a compensating advantage in that the district offered the opportunity as nowhere else to study the nature of the past glaciation. In most places the coast-land ribbon is so narrow that slight advances from the present ice front would completely cover the now exposed land areas.

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[2] Otto Nordenskjöld: Nord- und Südpolarländer, Leipzig, 1926, p. 14.

On reaching Holstensborg the *Morrissey* took on board a local pilot and proceeded by way of Ikertôk Fjord to the entrance to Maligiak Fjord, the head of navigation for such vessels. Near by on the east side of the fiord is a great amphitheater (see Fig. 3) rimmed by steep cliffs having an average height of about 1500 feet (Fig. 20). After a reconnaissance by motor boat to the head of the fiord it was decided to establish the main base of the Expedition within the amphitheater, which offered a good landing place and was supplied with an excellent stream of water, always difficult to find along the fiords of the district. The bay within the amphitheater we have named University Bay, and the peaks above the rim have been given the names of the past presidents of the University of Michigan. The camp itself is named after President Little.

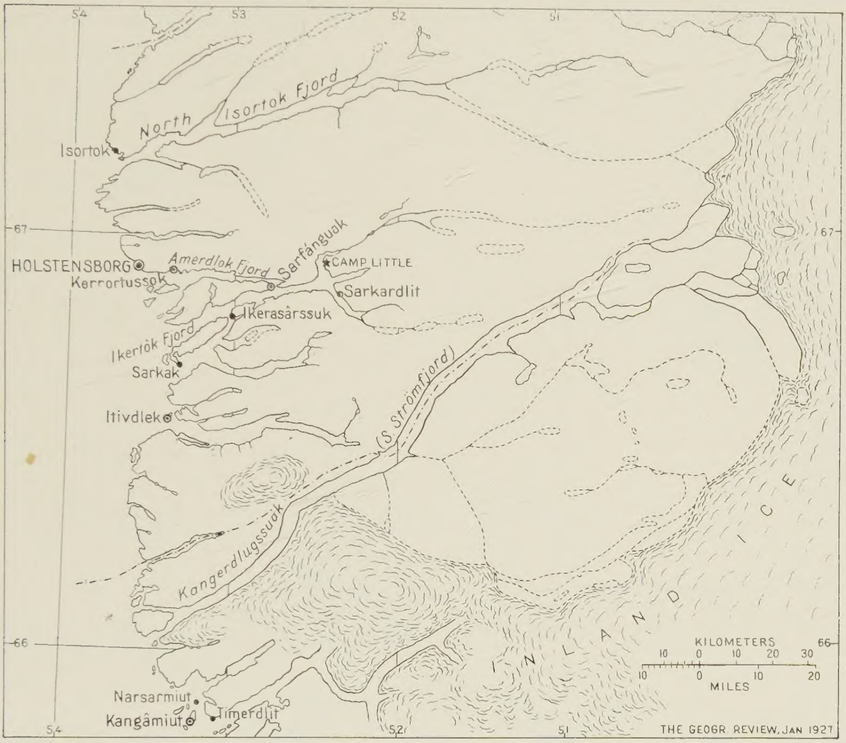

FIG. 2—Sketch map of the Holstensborg district from the official Danish maps. Scale approximately 1:2,000,000.

PERSONNEL AND EQUIPMENT

The personnel of the 1926 Expedition consisted of six members, whose attention was to be given especially to meteorological and glaciological studies, though surveying of the routes and preparation of maps were also in contemplation, as were also geological studies of a special character.

In addition to the writer as director, who was to make a study of glacial conditions and in a broad way of the meteorological problems, the party consisted of Professor Laurence M. Gould of the geology department at the University of Michigan, who acted as assistant director, geologist, and photographer; Mr. S. P. Fergusson of the United States Weather Bureau, upper-air expert and meteorologist; Professor J. E. Church, Jr., of the University of Nevada, meteorologist; Mr. Ralph L. Belknap, instructor in geology at the University of Michigan, surveyor and geologist; and Mr. P. C. Oscanyan, Jr., radio expert and a valuable assistant to Mr. Fergusson.

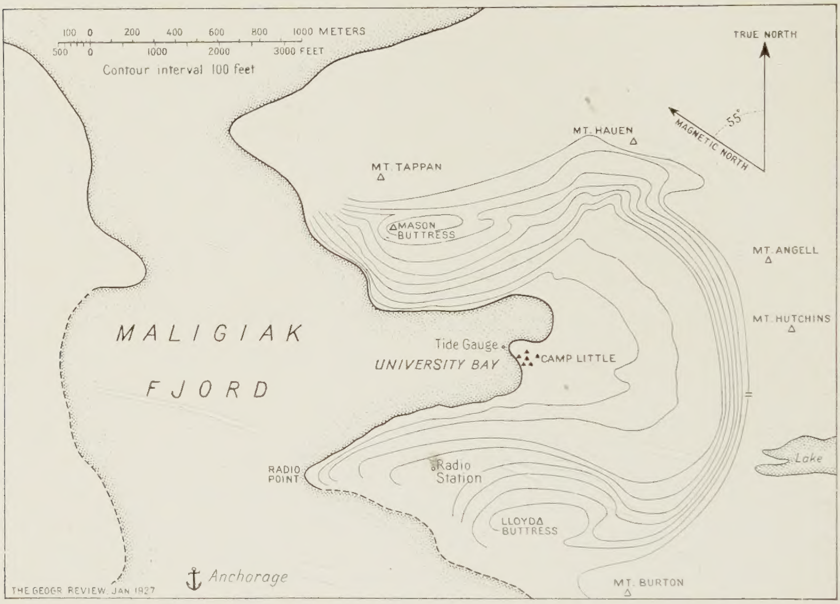

FIG. 3—The vicinity of Camp Little mapped by R. L. Belknap. [For Mt. Hauen read Mt. Haven.]

Dr. C. F. Marvin, Chief of the United States Weather Bureau, in addition to loaning the Expedition the services of Mr. Fergusson, either furnished or loaned the greater part of the meteorological equipment, including three of the new Fergusson meteorographs and one hundred and fifty pilot balloons. Dr. C. G. Rossby kindly furnished three of his new deflating devices for sounding balloons, which were of the greatest service in our upper-air studies. Colonel Lester C. Jones, Superintendent of the United States Coast and Geodetic Survey, loaned a new ten-second transit and a standard tide gauge. Professor Clarence E. Johnston loaned us from the equipment of the surveying department at the University of Michigan a thirty-second transit. The wireless installation was designed by Mr. John L. Reinartz, the well-known short-wave radio expert; and it was through his influence that we secured the services of Mr. P. C. Oscanyan, Jr., our radio operator. The batteries for our wireless station were contributed by the Burgess Battery Company of Madison, Wisconsin, the condensers were presented by the Allen D. Cardwell Company, the meters by the Jewell Electrical Instrument Company, a wave meter by the General Radio Company, storage batteries by the Exide Battery Company, and insulators by the Corning Glass Company. The State of Nevada Snow Surveys generously loaned the Expedition a valuable circut photographic camera with a Zeiss Protar lens.

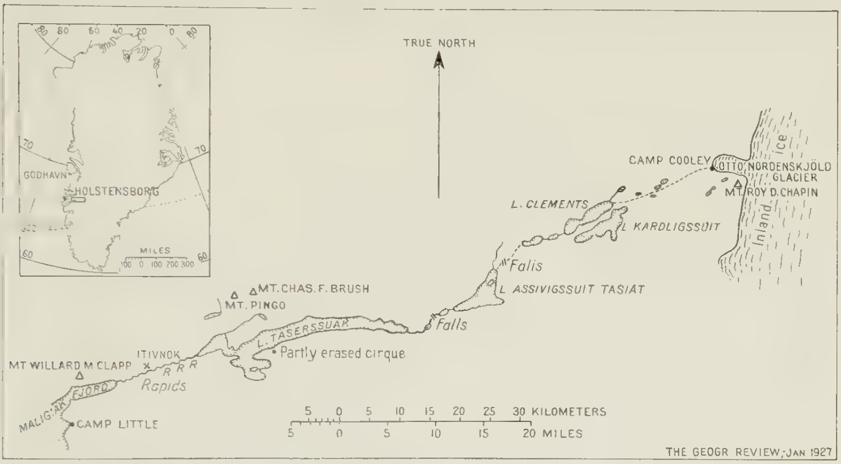

FIG. 4—The route to the inland ice from Camp Little mapped by R. L. Belknap. The larger lake between L. Clements and L. Assivigssuit is L. Offield. The inset shows the general situation of the area of the Expedition's explorations.

THE JOURNEY TO THE INLAND ICE

A party consisting of Hobbs, Gould, Church, and Belknap with four Greenlanders (half-breed Eskimos) set out on July 26 to cross the tundra to the inland ice with the intention of advancing over it for a period of eight to ten days. In many respects the late spring season is best suited for exploration in Greenland, because at this time the lakes are still frozen, and the ground buried in snow facilitates dog-sled travel. The summer season, to which the Expedition was limited by the regular duties of its personnel, is less favorable: advance across the tundra surface is necessarily slow, and the pest of insects is an almost continual torment.

The first section of the journey was made by umiak (Fig. 10), the large Greenland skin boat used primarily by the women, though we were towed to near the head of Maligiak Fjord by the Danish government sloop in charge of the manager at Sarfanguak settlement. By

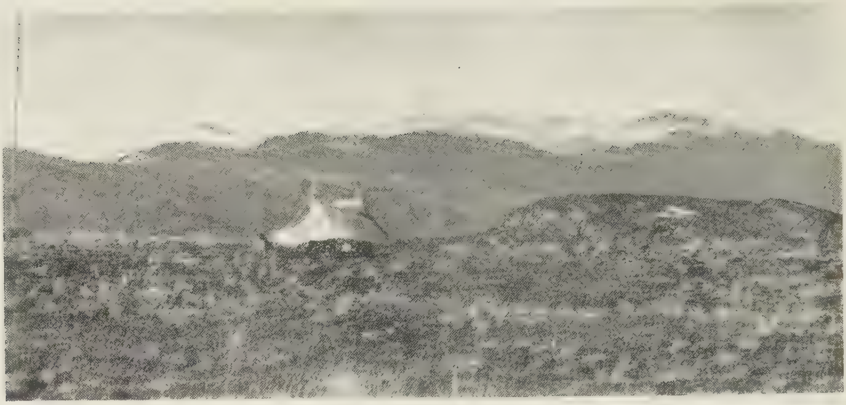

FIG. 5

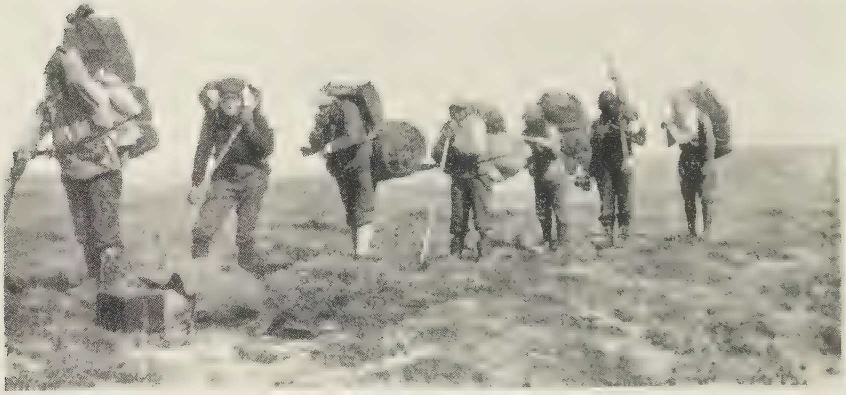

FIG. 6

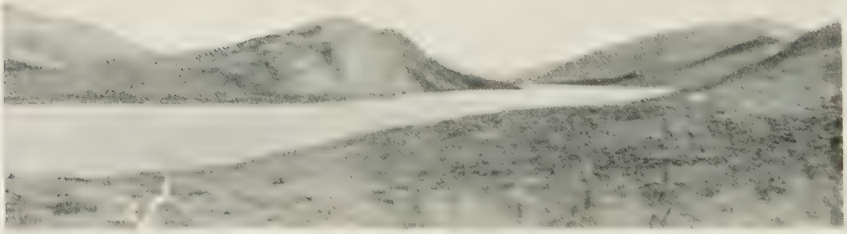

FIG. 7

FIG. 5—The first short-wave wireless station (see Fig. 3) to be erected away from the coast in Greenland: mast at extreme left. The station is at an elevation of 400 feet above Camp Little. In the distance at the right Mt. Willard M. Clapp. View taken in late August after the first snows had fallen in the higher levels. Maligiak Fjord is hidden just beyond the immediate foreground. (Photograph by L. M. Gould.)

FIG. 6—The ice-cap party en route to the interior; marching over the tundra after umiak and canoe have been left behind. (Photograph by L. M. Gould.)

FIG. 7—Subdued hilly topography within the hinterland belt. View of Lake Offield from the camp site at the southwest shore. (Photograph by L. M. Gould.)

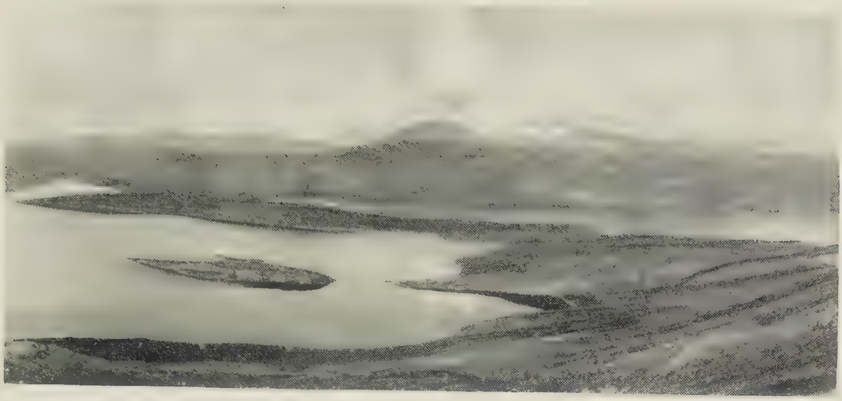

FIG. 8

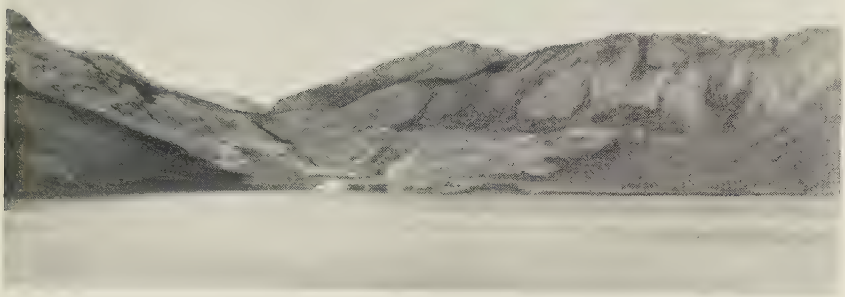

FIG. 9

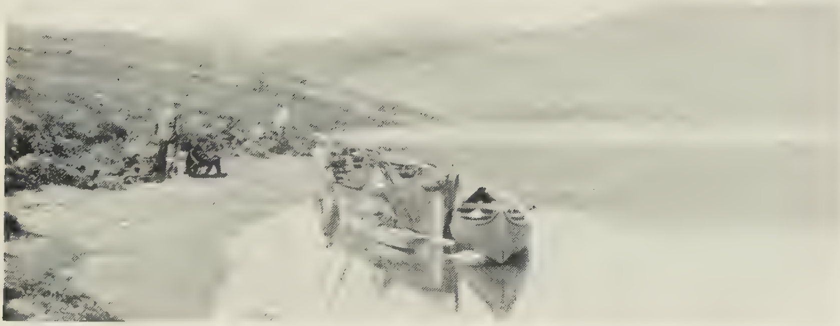

FIG. 10

FIG. 8—Looking northward across Lake Taserssuak from near its southwestern corner. Near the center is the Pingo, the highest point in the district; to the east Mt. Charles F. Brush. The foreground shows the effect of a second advance of the ice front, the distant ridge the flatly convex contours wrought by ice-cap extension at a high level. (Photograph by L. M. Gould.)

FIG. 9—The site of Nordenskjöld's camp at the northeast corner of the northwestern arm of Lake Taserssuak. Note the series of terraces cut through by a canyon. (Photograph by L. M. Gould.)

FIG. 10—Looking northwest from the south shore of Lake Taserssuak. On the horizon the convexly rounded contours of the Pingo and at its right Mt. Charles F. Brush. In the middle distance the strongly developed east-west strike of the gneiss. In the foreground the subdued contours of the hinterland, and the party's umiak, canoe, and kayak. (Photograph by L. M. Gould.)

unloading our cargo and portaging past the rapids of the river at Itivnok and poling and roping through the higher rapids, we were able to continue by umiak as far as the eastern end of Lake Taserssuak (Fig. 10), as Nordenskjöld had done in 1909.

The umiak was cached at the head of Lake Taserssuak, where a depot of provisions was left. We then proceeded on foot carrying heavy packs and an 18-foot Chestnut canoe weighing 75 pounds. The wisdom of taking with us the canoe was later manifest, for by portaging it a distance of 16 miles in all we spared ourselves packing more than 500 pounds a total distance of 75 miles (including relays) over moderately difficult terrain. Beyond Lake Clements, where the canoe was cached, we carried all our supplies, which included equipment for the 1927 expedition, upon our backs.

Arrangements made with the Greenlanders of the party required them to find their own provisions. Each brought with him an antiquated type of rifle, evidently expecting to depend in part upon game for food. The interior regions, however, proved almost devoid of any sort of game, if we except the flocks of wild geese that were generally too shy to approach near enough for a successful shot. Farther out towards the coast, ducks and ptarmigan (protected in the summer) were common, as was also the white arctic hare. In the far interior we found one fresh track only of caribou. On the other hand we came repeatedly upon ancient antlers of caribou half buried in the tundra, a fact which gives support to the suggestion made by the manager of the canning factory that a reindeer industry be inaugurated in the country. Hardly had we reached the margin of the inland ice —on the tenth day out from Camp Little—when the head Greenlander reported that his supply of food was exhausted. As we were now forced to feed from our own supplies eight men instead of four, it was necessary to reduce our stay on and near the inland ice to a period of four days and return by forced marches on reduced rations.

The Surface of the Inland Ice Near Its Margin

We first established contact with the inland ice on the outlet tongue which lies northeast of Camp Little about 65 miles as the crow flies and about 75 miles along the course traveled by us. This outlet was visited by Nordenskjöld in 1909, and it is with great pleasure that we have given it the name Otto Nordenskjöld Glacier (Figs. 11 and 12). It had been the expectation that after making the trek across the broad Holstensborg hinterland we should find the inland ice rising on flatter grades than is elsewhere generally the case, and in this we were not disappointed (Fig. 12). Camp Cooley on the southern margin of the outlet, near its front, is at an elevation as determined by aneroid of nearly a thousand feet, but this may be far from correct.

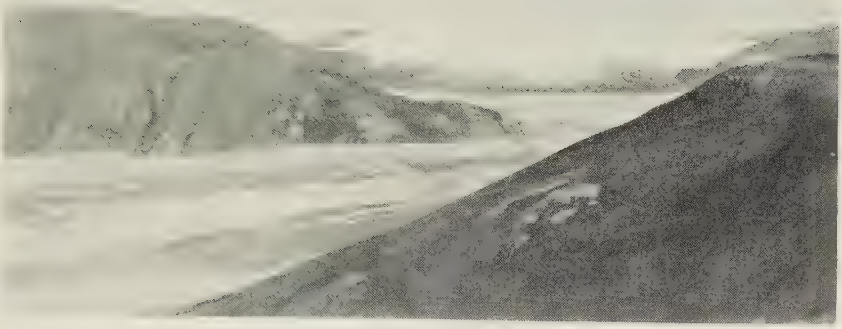

FIG. 11

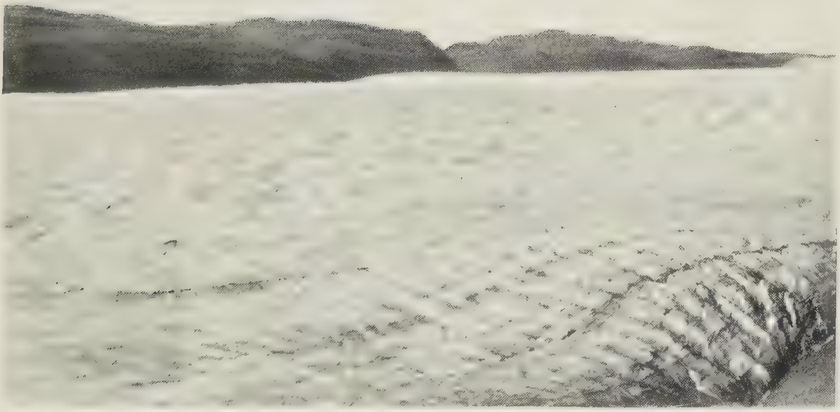

FIG. 12

FIG. 11—The front of the Otto Nordenskjöld glacial outlet from the inland ice. Before it in the valley the apron with its braided stream over a deep deposit of gray rock flour. This is so soaked with water as to make an impassable quagmire. Drying of its upper surface produces a powder-like loess, which is raised in clouds by the wind and spread over the tundra. The site of Camp Cooley is hidden behind the most distant ridge at the right of the picture. (Photograph by L. M. Gould.)

FIG. 12—View from Camp Cooley across the surface of the Otto Nordenskjöld Glacier. The crevassed surface makes the glacier almost impassable. (Photograph by L. M. Gould.)

Within the Nordenskjöld Glacier tongue there is sufficient forward movement to produce a quite rough and difficultly passable surface with seracs separated by canyons in which during the first week of August streams of water were in many places too wide to jump across. Some further detail of the surface topography farther in is to be seen in Figure 29. The glacier surface was without any covering of snow whatever, but near the lateral margins it was veneered thinly with gravelly materials which often encrusted cones and hillocks of ice from ten to fifteen feet in height. Midway of the southern margin of this glacier lies a beautiful ice-dammed lake perhaps a half mile across backed by vertical cliffs of ice within which the ice structure is clearly revealed. This lake I have named Lake Laurence M. Gould.

Glaciological Results

EXISTING GLACIERS OF MOUNTAIN AND ICE-CAP TYPES

In order to interpret properly those of our observations that relate to past glaciation within the coast-land ribbon, it is essential to give close attention to those processes by which the existing Greenland glaciers are modifying the rock surface beneath and about their borders. Contrary to some prevalent beliefs based wholly upon the past glaciations in North America and in Europe within moderate latitudes and on surfaces of low relief, glaciation outside the main interior mass of the Greenland inland ice presents a varied aspect.

As was pointed out in 1910[3] the inland ice of Greenland sends out from its margins tongues of two quite different types, (1) those which make their way down valleys to low levels and which therefore are joined to the inland ice by an ice amphitheater with fractured walls (Fig. 24) and (2) those which push their way out upon plateaus at high levels and make junction with the inland ice without noteworthy changes in grade and on generally smooth surfaces (Fig. 24). The former modify the rock terrane by erosion chiefly, causing a deepening of the rock trench within which they lie and a widening of it by sapping the side walls so as to produce U valleys and their extensions in fiords.

The high-level tongues, on the contrary, since they have no rock above them, in general merely degrade the underlying rock and progressively plane off the existing irregularities of its surface so as to yield flatly rounded contours convex upward. At the front of these high tongues where the ice becomes thinned, in the event that there are irregularities of the rock terrane, frost weathering by alternating thaw and freeze yields the peculiar features resulting from weathering in such altitudes wherever glacial ice is present. We find sharply

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[3] W. H. Hobbs: Characteristics of the Inland Ice of the Arctic Regions, *Proc. Amer. Philos. Soc.*, Vol. 49, 1910, pp. 57–129; reference on pp. 81–84.

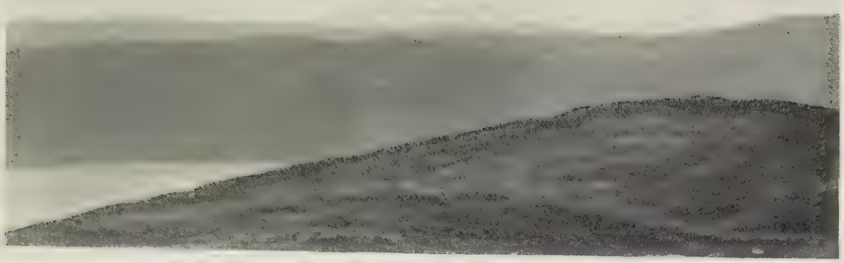

FIG. 13

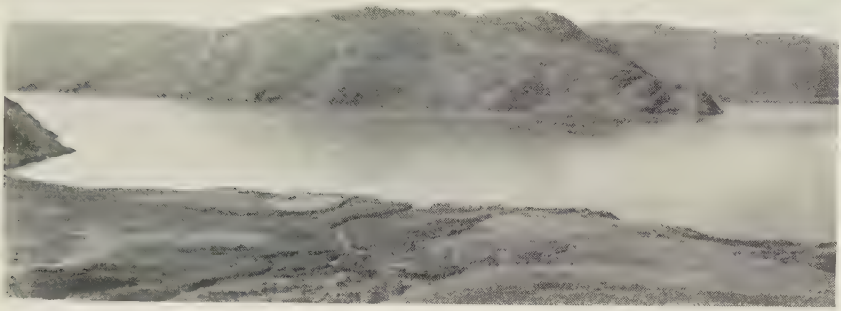

FIG. 14

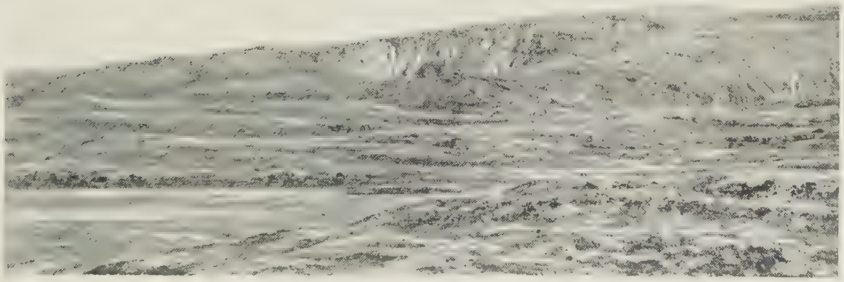

FIG. 15

FIG. 13—Looking southward across Ikertôk Fjord. The dark shadows on the glacier are the walls of cirques over which the inland ice sometimes cataracts. To the east (left) the glacier covers all the land as a carapace and as such is joined to the inland ice. (Photograph by L. M. Gould.)

FIG. 14—Looking southwest from above Nordenskjöld's camp on the northwestern arm of Lake Taserssuak. At the left the relatively smooth contours shaped by the later advance of the ice front: at the right beyond the nearest headland a partly submerged cirque resulting from mountain glaciation at the front of a high outlier from the inland ice. (Photograph by J. E. Church, Jr.)

FIG. 15—A cirque on the south shore of Lake Taserssuak formed by mountain glaciers during a retreat of the ice front but largely erased by erosion beneath the ice during a later readvance. The walls polished by glacial erosion: elevation of floor about 700 feet. (Photograph by L. M. Gould.)

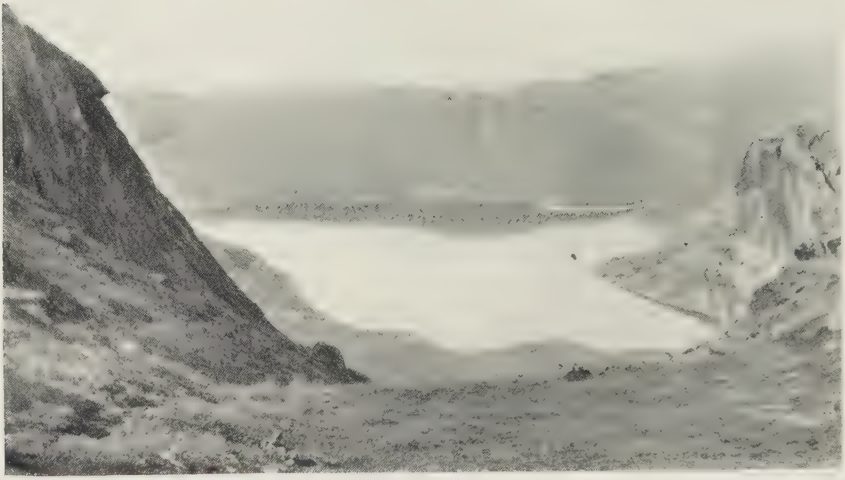

FIG. 16

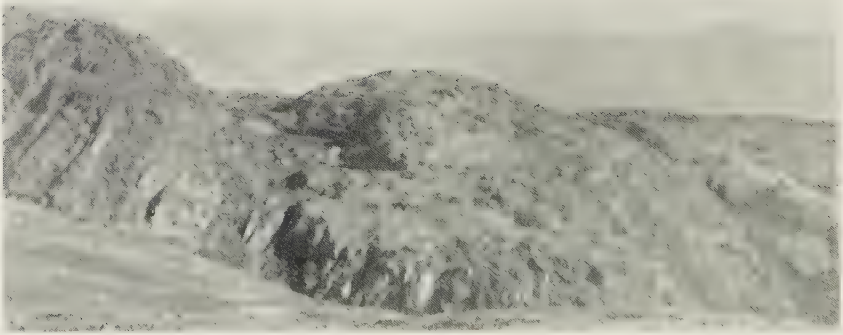

FIG. 17

FIG. 16—University Bay on the eastern side of Maligiak Fjord as seen from a pass in the cirque rim at an elevation of about 900 feet. The view looks westward, and Camp Little is near the center of the nearer shore (see also Figure 20, which looks into the Bay from across the fiord). (Photograph by W. H. Hobbs.)

FIG. 17—Looking southward across the upper part of Maligiak Fjord (faintly seen in left middle distance) at the high country, which has been glaciated by a single advance of the ice front. Beyond the visible part of the fiord are seen two of the great fault escarpments of the block pattern. (Photograph by W. H. Hobbs.)

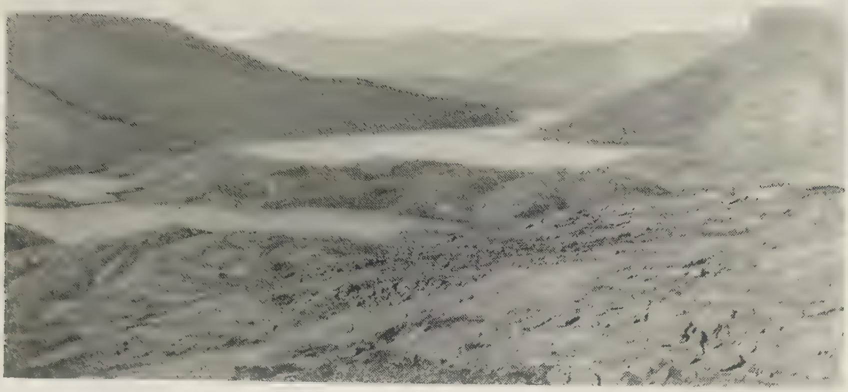

FIG. 18

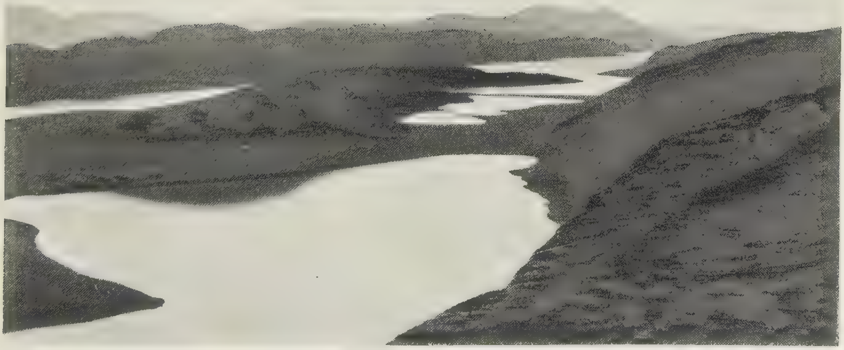

FIG. 19

FIG. 18—Looking northwestward from a high point north of Maligiak Fjord and showing the numerous lakes on the high plateau with their noteworthy rectangular outlines determined by the fracture pattern within the rock beneath. In the right middle distance fault escarpments, and in the distance an isolated ice cap with marginal tongues. (Photograph by W. H. Hobbs.)

FIG. 19—The characteristic high plateau country of the Holstensborg district with its numerous glacial lakes in rock basins. The latter betray by their outlines the fracture pattern. (Photograph by L. M. Gould.)

accented surfaces that are concave upward and are characteristic of the fretted upland—cirques, cols, comb ridges, etc.[4] The degree of accent in the relief is dependent on the time the action continues, but frost weathering is one of the most rapid of all degrading processes. The fretted upland which is developed under these conditions differs from that formed by the true mountain glaciers of lower latitudes in that, in its pre-mature stage of grooved upland, the rock surface above the cirques is covered with a carapace of glacial ice and is planed and polished by its action. This high-level glacier often cataracts into the cirques below, where the ice may even be rejuvenated into a new glacier born within the cirque.

Nordenskjöld with keen insight established the fact of these conditions when he studied the margin of the Greenland inland ice on Scoresby Sound and other localities of east Greenland in 1899, and later, in 1909, in a study of the long arm of the inland ice that pushes out nearly to the sea south of the Kangerdlugssuak (southern Stromfjord)[5].

Whenever a high tongue from the inland ice undergoes an advance, and much the same may be true for isolated bodies of carapace glacier, erosion beneath the advancing carapace erases the pinnacles of the fretted upland at its front and at the same time progressively shallows the basins of the cirques. In a map of James Ross Island in West Antarctica Nordenskjöld has represented a carapace above such shallowed cirques into which in one instance—the Hobbs Glacier—it discharges a cataract of glacier ice.[6]

The surface of the rock above such shallowed cirques when laid bare will be found to be planed, polished, and striated; in which respect it is in striking contrast, though similar in form, to the premature grooved upland such as is to be found in the Uintah and Big Horn Mountains. Classical examples from past glaciation by continental glaciers are to be found in northern Norway, where the partly erased cirques have been described as *kjedels*. It is worth noting that Nordenskjöld has compared the region surrounding the inland ice of Greenland to that of Norway with its former and its present existing ice caps.

EVIDENCES OF FORMER GLACIATION BY INLAND ICE

Without study of the action which goes on in high levels at the front of the inland ice as given in the preceding section, no intelligent

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[4] W. H. Hobbs: Earth Features and Their Meaning, New York, 1912, pp. 367-382.

[5] Otto Nordenskjöld: On the Geology and Physical Geography of East-Greenland, *Meddelelser om Grønland*, Vol. 28, 1907, pp. 151–284; reference on p. 261. Also *idem:* Einige Züge der physischen Geographie und der Entwickelungsgeschichte Süd-Grönlands, *Geogr. Zeitschr.*, Vol. 20, 1914, pp. 425–441; 505–524; 628–641; reference on pp. 430–432.

[6] Otto Nordenskjöld: Die Schwedische Südpolar-Expedition und ihre geographische Tätigkeit (Wissenschaftl. Ergebnisse der schwed. Südpolar-Expedition 1901–1903, Vol. 1, Part I), Stockholm, 1911. See also W H. Hobbs: Studies of the Cycle of Glaciation, *Journ. of Geol.*, Vol. 29, 1921, pp. 370–386; reference on pp. 382–386.

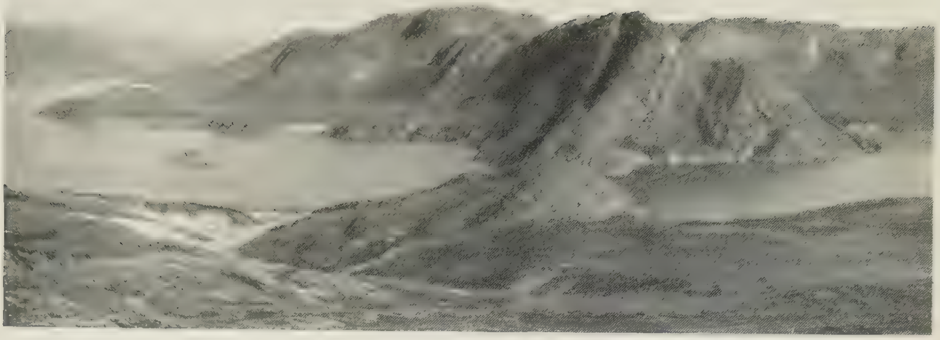


FIG. 2

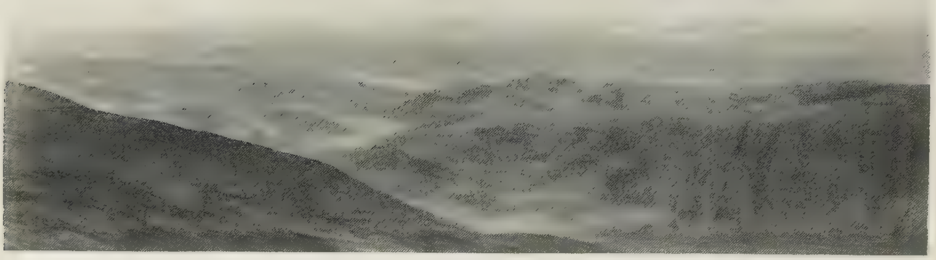


FIG.

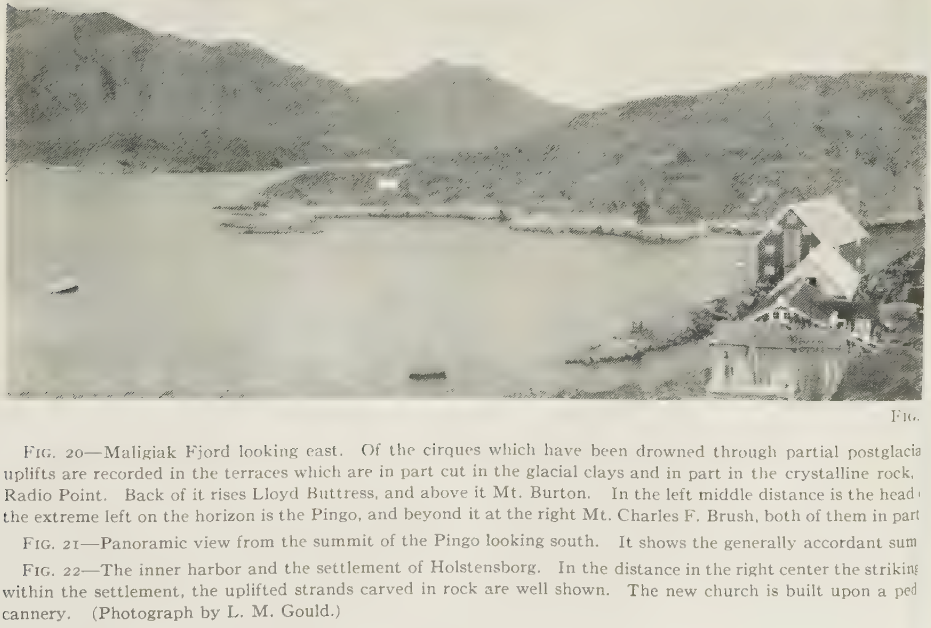
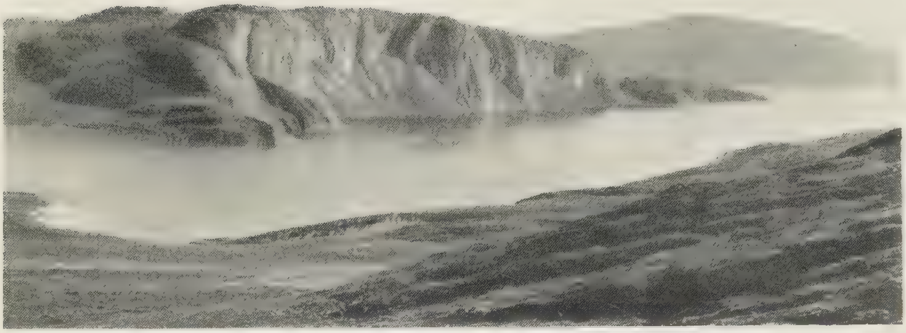


FIG.

FIG. 20—Maligiak Fjord looking east. Of the cirques which have been drowned through partial postglacia
uplifts are recorded in the terraces which are in part cut in the glacial clays and in part in the crystalline rock,
Radio Point. Back of it rises Lloyd Buttress, and above it Mt. Burton. In the left middle distance is the head
the extreme left on the horizon is the Pingo, and beyond it at the right Mt. Charles F. Brush, both of them in part

FIG. 21—Panoramic view from the summit of the Pingo looking south. It shows the generally accordant sum

FIG. 22—The inner harbor and the settlement of Holstensborg. In the distance in the right center the strikin
within the settlement, the uplifted strands carved in rock are well shown. The new church is built upon a ped
cannery. (Photograph by L. M. Gould.)



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l submergence of the district, the central one in the picture encloses University Bay and Camp Little. Late
he latter seen especially well in the left middle distance. The headland at the right of University Bay is
f Maligiak Fjord, and beyond it the meandering Itivnok River, along which is the route to the inland ice. At
covered by the snows of late August. (Photograph by L. M. Gould.)

nit levels of the higher ridges and the numerous lakes. (Photograph by L. M. Gould.)

Kaerlingerhaetten (old woman's topknot) which may be seen from far out at sea. Throughout, but particularly
stal-like top and represents one of the higher shore lines. The large building in the foreground is the new

inquiry into past glaciation can be carried out. It is further necessary to have regard at all times to the profound changes in level, and particularly the subsidences, which have gone on since the glaciation, if trustworthy conclusions are to be drawn. The resemblance in this latter respect to the peninsula of Norway is a vital one. It is, moreover, exactly the study of the earlier cirques and the fact that they develop only on relatively high plateaus, that permits us to judge from their present position the extent of the subsidence which has characterized the land block within which they are found.

So far as my observations have gone, the entire exposed area of land within the Holstensborg District has at one time been covered by inland ice. The vicinity of the settlement of Holstensborg itself shows the characteristic rock contours and the other indications of glaciation beneath inland ice (Fig. 22), except where these have been planed away by marine erosion and lifted to their present position.

The High Coastal Belt and the Low Belt of the Hinterland

Nordenskjöld in his monograph so often cited here has emphasized the contrast between the rugged belt of country near the coast and the hilly region at lower levels lying behind it. On his sketch map[7] the coastal region is described as "normal mountain region with prevailingly rounded features" and the inner low region as "hilly land." This contrást we have confirmed, but the matter is not altogether simple. Examples of the topography of the coastal belt, though not that in immediate vicinity of the main coast, are represented in Figures 17, 18, 19, 20, 21, and 23; that of the low hinterland in Figure 8 (foreground) and in Figure 15. At the right in Figure 14 is shown the coastal type of topography, and to the left a small area of the smoother interior region.

In contrast to the near coastal area about Camp Little, which has an average altitude exclusive of the fiords of perhaps 1300 feet, the hinterland has an average elevation of probably two-thirds that amount. Though within both of these areas the higher surfaces particularly show convexly rounded contours, within the outer district there is a noteworthy ribbed pattern due to the dominant east-and-west strike of the crystalline rock—a sort of glorified *roches moutonnées* topography. Within the interior district this ribbed structure has largely disappeared through increased glacial denudation. Within both belts the large erratics are chiefly restricted to the tops of the higher ridges, and in both also they are much weathered,[8] but within the exterior belt one practically never finds erratics which reveal distinct glacial faceting or striation. In the hinterland belt, by contrast, faceted and striated boulders are not uncommon.

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[7] Nordenskjöld, Einige Züge der physischen Geographie, p. 427, Fig. 1.

[8] *Ibid.*, pp. 514–515.

The surface of the rock pavement within the interior region is well polished even where not protected by deposits. Where it has such protection by glacial clay the marks of glaciation are remarkably well preserved (Fig. 25). For the outer belt, except along the fiords, such polished pavement is seldom found.

In further contrast to the exterior belt the inner one has its surface plastered with a thick deposit of gray glacial clays, and this veneer extends to the summits of the highest ridges. Such clays show in much perfection the operation of the subarctic process of solifluction, the pattern on flat surfaces being the hexagonal mosaic and on slopes a down-slope ribbed structure often divided by cross fractures into elongated rectangular segments. Owing to the dryness of the summer season the clay is usually hard and sometimes almost stony. Connected with this solifluction is the process of nivation, and the embryonic niches[9] show many stages.

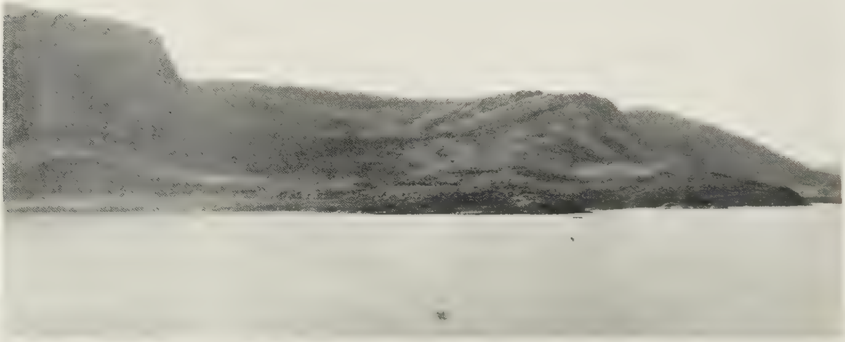

FIG. 23—Looking southward across Maligiak Fjord and showing two of the great fault escarpments which outline the block pattern of the relief. These have generally determined the position of the imperfectly rectangular cirques now in part submerged. Near the shore are seen terraces from uplifted strands. (Photograph by L. M. Gould.)

The above described characteristics of the hinterland belt apply especially to the route followed by us to the inland ice, where our course was for much of the way along shallow trench-like valleys more or less connected. A high east-west ridge to the north of Lake Taserssuak is characterized by smoothly rounded knob-like projections and extends eastward far into the interior and westward to about the longitude of the head of Maligiak Fjord. This ridge supports the great dome of the Pingo (4350 feet) and the elongated one of Mt. Charles F. Brush, as well as many others; it is believed to have been shaped beneath a high-level tongue which pushed out from the inland ice in much the same way as did that now existing south of the southern Stromfjord (Fig. 2).

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[9] Hobbs, Characteristics of Existing Glaciers, p. 21, Fig. 8.

The checkerboard pattern of the surface topography prevails throughout the Holstensborg district and is due to the fault pattern within the underlying terrane (see below, p. 34). In the exterior belt this pattern is accentuated by escarpments whose height is many hundreds of feet (Fig. 23). By contrast, within the inner belt, as, for example, across the broad valley to the southward from the prominent waterfall below Lake Assivigssuit Tasiat (see Fig. 4), the lines of this pattern can be followed with the eye for many miles although the irregularities have now been largely planed down. Particularly within the outer belt the abundant lakes upon the plateau are remarkably irregular of outline and present rectangular elements which bring out strikingly the checkerboard pattern (Fig. 18).

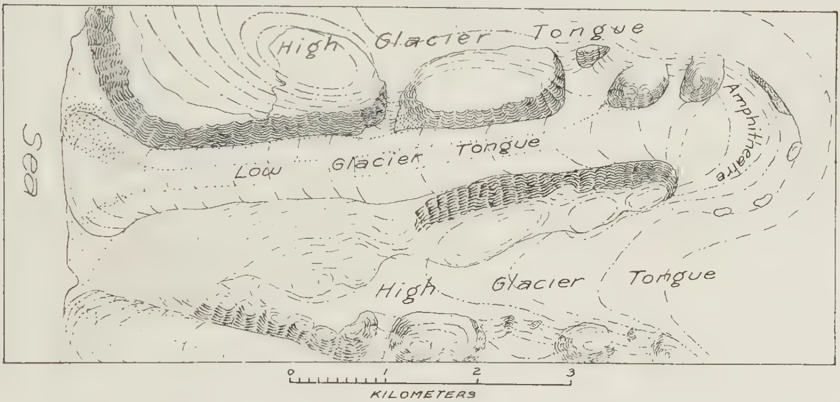

FIG. 24—Map of the area east of Umanak Fjord to show the characteristics of a low tongue (outlet) from the inland ice and also a high one from the same mass. (After von Drygalski.)

At about the same time that the high-level tongue of ice covered the higher ridge north of Lake Taserssuak a long low-level outlet tongue extended down the great trench formed by the northwestern arm of the Taserssuak and its extension in the present flood plain of the Itivnok River and Maligiak Fjord. Along this valley, particularly at the lower levels which are still exposed above tide, the glaciation of the rock surface is perfectly preserved. This tongue of ice through blocking drainage lines has left behind a large series of lake terraces. The parallel high-level and low-level ice tongues here described recall by their position the similar ones now existing at the head of the Umanak Fjord (Fig. 24).

READVANCE OF THE GREENLAND INLAND-ICE FRONT

Our interpretation of the above evidence is that after an earlier advance of the continental glacier, which extended at least to the present coast, there was a retreat of this front followed by the formation of cirques along the margins of the higher ridges (see above, p. 14 and Fig. 13). A later readvance of the front as far as the western end of the southern arm of Lake Taserssuak brought about the much greater degradation within the hinterland. At the same time a long arm pushed its way out at a higher level upon the ridge supporting the Pingo.

The moraines throughout the Holstensborg district, in so far as they have form, are largely those left behind by the low-level tongues of ice, and these are usually of the terminal or lateral types. They are especially well formed within the valley below Lake Offield. A very heavy one, also, with a curiously concave front no doubt indicating a late stage, is found at an elevation of about 1575 feet to the northward of Maligiak Fjord near its head. The front of the ice when it was without extended tongues seems to have produced no depositional features whatever, though heavy deposits of rock flour remain within the fiords, and much has clearly been removed, as is shown by the steps of the elevated strands cut in them (Fig. 20).

Farther in toward the margin of the inland ice the trenched character of the topography, so noticeable farther out, becomes subdued. We encounter a type of surface which is more nearly within one plane and above which rise peculiar knob-like hills in great numbers (Fig. 7). This surface was shaped, it was believed, not beneath tongues of ice of either type but beneath the broad mass of the ice dome itself. With much probability a surface of this general character forms the basement of the marginal portions of the inland ice today.

Cirques of the Twice Glaciated Hinterland Belt

Perhaps the most convincing evidence for a later readvance of the inland ice is supplied by the partly erased cirques. On the northern face of the ridge that rises south of Lake Taserssuak (Fig. 15) the floor of a cirque of this type is now about 700 feet above the sea, and the surrounding rock surface is planed and smoothed.

As is well known, it is the floor alone of cirques that has been shaped directly by glacial erosion. The surrounding walls have been given their form by the process of sapping, and they present surfaces formed by separation of the rock generally along joint planes. Here, however, the walls of the partially erased cirque testify to the readvance of the ice front by their well polished surfaces glistening in the sun (Fig. 15). One other example of a largely erased cirque is found in the valley below Lake Offield with its floor at an elevation above 400 feet.

Greenland cirques, as has been already pointed out, are features shaped at relatively high levels in connection with the plateau extension of the inland ice. According to Nordenskjöld the upper

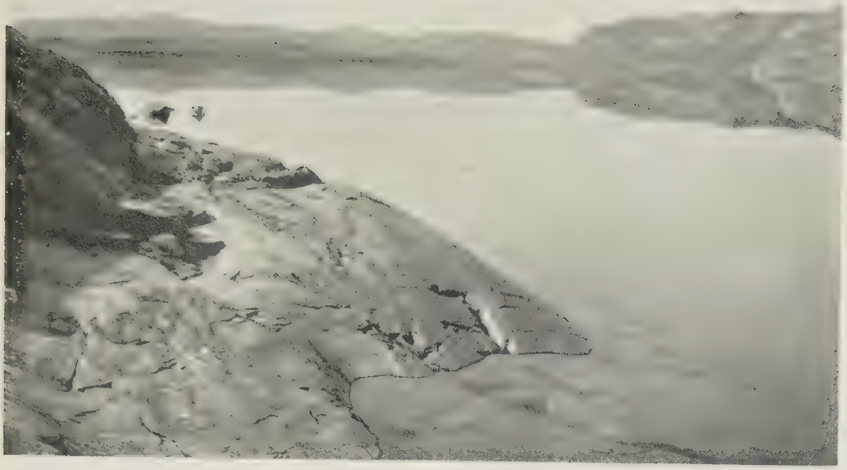

FIG. 25

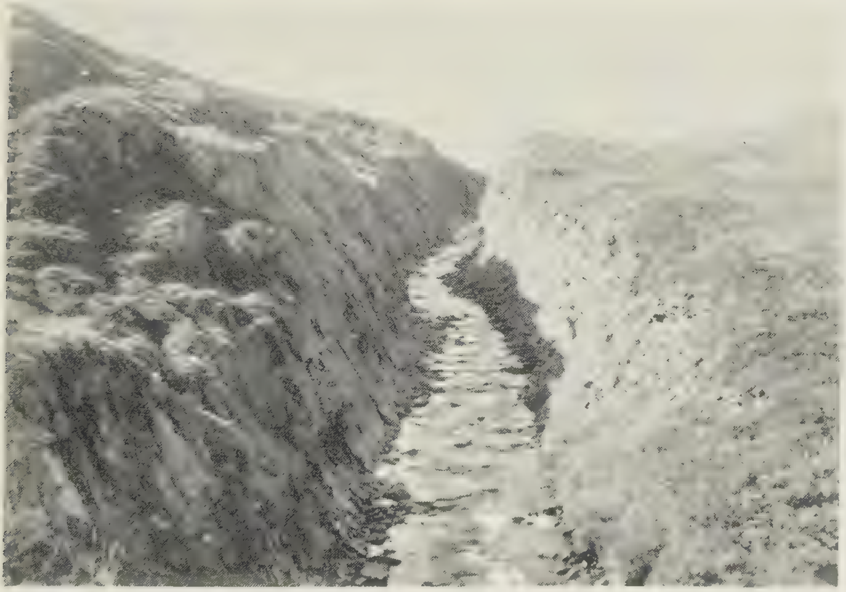

FIG. 26

FIG. 25—Looking west from the south shore of Lake Taserssuak. In the foreground is seen the perfect polish and striation of the crystalline rock wherever this has been overridden by the second advance of the ice front. (Photograph by L. M. Gould.)

FIG. 26—One of the rectilinear canyons formed on a displacement and here about 50 feet deep. Below the margin of the picture in the foreground this canyon turns sharply to the right to form an almost perfect right angle. The locality is across Maligiak Fjord from Camp Little in a northwesterly direction. (Photograph by L. M. Gould.)

levels of these cirques on the margin of the ice tongue south of the Holstensborg district lie above 3000 feet of altitude. We have as yet no data concerning the level of their floors, but these are probably well above 2000 feet. Throughout what appears to have acted as a great composite earth block extending from the Maligiak Fjord to Taserssuak, the cirques are near to or at present sea level (Figs. 14 and 20). It is difficult to explain these observed conditions in any other way than as due to subsidence amounting in the aggregate to at least from 1000 to 2000 feet. It is this postglacial subsidence that is responsible for the fiord system, probably the most remarkable in the world.

In the block represented by the main body of Lake Taserssuak, although the general level of the land is lower than in the exterior belt (at least along the route we followed) the partly erased cirque above described has its floor now at an elevation of about 700 feet. Below Lake Offield a second partly erased cirque has its base at an elevation of over 400 feet—both elevations as determined by aneroid. It would appear, therefore, that the subsidences of the larger land blocks within the Holstensborg district have been greatest in the block that includes Camp Little and notably less in the next block toward the interior, that which includes Lake Taserssuak. This is what we should expect, both from the depths of the fiords and as a progressive subsidence of the high interior outward toward the sea. This has special interest in connection with past glaciations, since it shows that the excess of glacial denudation within the hinterland belt over that of its immediate foreland has been even greater than is represented by the differences of average summit levels today.

Meteorological Results

Systematic Meteorological Observations at Camp Little

A few days after our arrival at the base camp two standard Weather Bureau barographs and two Weather Bureau thermohygrographs had been tested, set up, and were recording within a shelter of the French pattern. At about the same time cloud observations were begun and were continued by Mr. Fergusson at regular intervals until camp was broken on September 3.

Although a standard anemometer was taken and set up at Camp Little, it was soon found that the winds observed at such low levels, where the topography is of the west Greenland type, tell us little except the directions of the sluiceways within which they blow. To Greenlanders it is a well known fact that the wind blows lengthwise of the fiords, so that it is futile to seek shelter from a strong wind by doubling a headland in the fiord. At Camp Little the wind also reverses direction with remarkable suddenness.

Of immediate results at Camp Little Mr. Fergusson reports the most striking to be the unusually low wind velocities, the great height of the lower clouds, the large ranges of temperature and their sudden changes, the low atmospheric pressure which never at any time exceeded 1012 millibars (29 inches), and the extremely low precipitation.

As regards these conclusions, it should perhaps be pointed out that the present summer season in western Greenland was abnormal in having fine clear weather. Probably no one living is more competent to give an opinion upon this subject than Dr. Knud Rasmussen, since he has spent his lifetime in Greenland, and he told the writer that never had he known so fine a summer season.

Mr. Fergusson reports:

> The most conspicuous meteorological phenomena of the summer are the very small precipitation (only about 16 millimeters occurring during the 9 weeks), a high average cloudiness, low atmospheric pressure, and—perhaps most noteworthy of all—the very slow movement of the wind at all heights, determined from observations of clouds and balloons. The heights of the clouds below the alto-stratus appear to be decidedly greater than those of the same clouds in lower latitudes, even during periods of storm lasting several days. At the surface of the ground and particularly near the large fiords the familiar diurnal phenomena of sea and land breezes, intensified at times by the air coming from the inland ice cap, are very marked, the velocity of the air probably occasionally exceeding ten meters a second. These surface winds, as is the case elsewhere, do not extend very high (seldom more than 100 meters and frequently only to half this height), and when a cyclone of more than ordinary intensity prevails the diurnal and local phenomena become insignificant.

Before we departed for Greenland several European meteorological services having stations not too remote from Greenland were requested to carry on regular observations of the directions of the higher clouds, particularly during the period of our stay in Greenland. It is with much pleasure that I report that cloud observations of this nature were made regularly by Dr. Thorkel Thorkelsen at Reykjavik, Iceland. Through the courtesy of Dr. Thorkelsen these observations will later be compared with those made by Mr. Fergusson at Camp Little.

Observations During the Journey to the Interior

Throughout the twenty-two day journey to the inland ice Professor Church with painstaking care carried out regular three-hourly observations both day and night with a standard psychrometer to determine air temperature and humidity for comparison later with the records of the thermohygrographs at Camp Little. Of them he reports as follows:

> The methods employed were typical of reconnaissance work. The Danish weather station at Holstensborg was used as a basis of comparison but with the addition of the balloon station at Camp Little as an intervening point. The records

at the former station represented readings taken daily at 8 a. m. and 2 and 9 p. m. Those at Camp Little were continuous traces of temperature, pressure, and humidity, while the readings on the inland trip were taken every three hours throughout the twenty-four hour period. A sling psychrometer, aneroid barometer, anemometer, and pocket compass made up the outfit. Except for four days at the inland ice, the party was practically in constant motion. However, the topography was not sufficiently diverse to prevent the combination of the daily readings into individual groups.

TABLE I—TEMPERATURE AND HUMIDITY, HOLSTENSBORG DISTRICT AND SIERRA NEVADA

Temperature (F.)	HOLSTENSBORG	CAMP LITTLE	INLAND	RENO
Mean	47.8°(*a*)	48.6°	49.2°	69.6°
Maximum	57.6°	69.0°	64.0°(*b*)	97.0°(*c*)
Minimum	39.7°	32.0°	31.0°	36.0°
Mean Range	9.6°(*d*)	17.8°	18.7°	34.6°
Humidity (per cent)				
Mean		70.6(*e*)	63.7	25.3
Mean, Maximum		86.9	78.9 (Taserssuak)	39.3
Mean, Minimum		52.4	44.7 (Edge inland ice)	16.3

a. Reduced from 49.4° on the basis of more numerous daily measurements at Camp Little.

b. Possibly lower than at Camp Little because of increase in elevation.

c. Maximum temperature on Mt. Rose (10,800 feet) near Reno 72.3°, or practically that in Greenland.

d. Uncorrected range 4.4°, caused by lack of minimum temperature in record. Minimum occurs approximately at 2 a. m.

e. This represents a correction of approximately 7 per cent for instrumental error. If applied throughout the entire series, the mean would have been 2 per cent higher still.

Because this district of Greenland has been described as semiarid rather than moist, comparison is further made with the hill country of Lake Tahoe and Reno on the eastern slope of the Sierra Nevada on the edge of the Great Basin. Individual but similar periods rather than normals are employed. The period for Greenland covers July 27–August 17, and for the Sierra Nevada August entire. The evaporation studies (see Table III), however, cover the period of August 18–September 2 after the return from the inland ice.

(1) *Temperature.* The disparity of 11.9° F. found by Nordenskjöld to exist between Holstensborg and Inner Greenland sinks to 1.4° F. under a longer comparison and more frequent readings. However, the temperature shows a steady though slight increase from the ocean to the inland ice. Length of record and lack of space compels the use of means and extremes in this and other tables.

On the basis of the mean of 48.4° F. for June–July, 1909, quoted by Nordenskjöld, the present season in Greenland could not have been abnormally warm. The only abnormal element must have been the lack of precipitation or wind, either of which would increase human comfort noticeably.

2. *Relative Humidity.* The relative humidity of the hinterland is only slightly less than at the head of the fiord. However, it is lowest at the edge of the inland ice, thus indicating a gradual decrease inward from the sea. Unfortunately, no humidity measurements at Holstensborg are available.

STEPPE CLIMATE OF THE HINTERLAND AND ITS PROBABLE CAUSE

In describing[10] the "warm dry steppe region on the border of the inland ice" Professor Nordenskjöld brought out many interesting observations, such, for example, as the saline content of the rock-basin lakes, in support of his opinion. Our experience within the same region is confirmatory of his. On the entire twenty-two days of the journey to the inland ice we had only a few hundredths of an inch of precipitation; day after day there were clear skies with remarkable development of cirri in new and varied patterns which surpassed those observed in all our earlier experiences. At such times of clear weather we not infrequently saw showers over the summit of the Pingo and in the far western skies, though later reports showed that the weather at such times was uniformly good at Camp Little.

TABLE II—ANALYSIS OF WATER OF THREE GREENLAND LAKES
(*Percentages*)

	ILIVILIK	ITIVNOK	ABOVE TASERSSUAK*
SO_3	44.31	50.55	23.6
Cl	9.07	8.80	5.0
CO_2		0.85	
$Fe_2O_3 + Al_2O_3$		2.80	
MgO	3.48	2.98	5.8
CaO	3.21		16.5
Na_2O	28.19	33.02	23.3
K_2O	4.99	1.00	2.6
Silica (SiO_2)			4.0
Iron and Aluminum Oxides			16.4†

*Analysis by Wayne B. Adams, chemist of the Division of Food and Drugs Control of the University of Nevada, as a voluntary service to the Greenland Expedition.

† "Iron and aluminum content would probably be lower when the water was fresh and in its original state."

Of the numerous interior lakes the majority lie in rock basins, and, as very many of them are without outlets, it is hardly surprising that they are brackish. Only once, however, did we find a lake of which the water was so salty as to be unpalatable. A sample of this water from east of Lake Taserssuak was taken by Professor Church, who has had it analyzed to compare with samples collected by Nordenskjöld from Ilivilik and Itivnok as shown in Table II.

Though the season of 1926 was abnormal and though our temperature records reveal no such sharp contrasts as Nordenskjöld thought he had found between the remote hinterland and the coast district, it is not doubted that the Holstensborg district generally as compared with districts to the north or south enjoys a warmer and drier climate. For this there is believed to be a good explanation in the peculiar position of the high ice tongue to the south of the southern Stromfjord, as may be seen by reference to the map, Figure 2. As is well known and as was long ago pointed out by Rink, the easterly winds blowing off the inland ice have the warm and dry characteristics of the föhn and are accompanied by clear skies, whereas the rains are brought by low pressure areas that move up Baffin Bay from the south. The one district from which these rain-bearing winds can be cut off by an ice tongue is the Holstensborg district. This ice tongue holds a unique position, for the only other ice tongue that pushes out to the sea on the west Greenland coast is the Frederikshaav Isblink far to the south, and since this takes a southwesterly direction it is no barrier to the progress of the rain-bringing "lows." A rather remarkable instance of excessive insolation such as is best observed in arid regions is illustrated in Figure 33.

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[10] Nordenskjöld, Einige Züge der physischen Geographie, pp. 509–514.

STUDIES OF TRANSPIRATION AND EVAPORATION

To one not familiar with arctic conditions, the survival throughout the summer season of the stunted vegetation upon the small rainfall seems a marvel. It is, however, easily explained. At a depth of one to two feet below the surface of the tundra a solid mass of ice is encountered even in midsummer, and above this nonpermeable base the supply of moisture from the snow-melting period in the spring is conserved as though in a sponge. Professor Church reports:

> Quite in keeping with the low temperature of air and water and the relatively high humidity is the low rate of evaporation and transpiration, the former being approximately one inch as compared to more than seven inches at Lake Tahoe. Furthermore, the period represents one of the two warmest months in an apparently dry summer. Thus the enigma of light precipitation and vigorous growth becomes explicable. The experiment was conducted with Mt. Rose apparatus and by methods used in studying evaporation of snow. Owing to lack of space, only the summary in Table III is given.

THE GREENLAND GLACIAL ANTICYCLONE

The primary object of the University of Michigan's Greenland Expedition is study of the Greenland glacial anticyclone.[11] The continent of Greenland operates upon the earth's atmosphere as a great refrigerator, whereas the belt along the equator may by contrast be compared to a furance. It is in reality the differences in temperature of these areas—not the high temperature of the latter only—which, in so far as the northern hemisphere is concerned determine the vigor of the disturbances within the earth's atmosphere.

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[11] W. H. Hobbs: The Glacial Anticyclones: The Poles of the Atmospheric Circulation, With an Introduction by Hugh Robert Mill (Univ. of Michigan Studies, Sci. Ser., Vol. 4), New York, 1926.

We are not here dealing with a mere theoretical conception but with an empirical law the basal observations for which were made by the late Admiral Peary when he discovered that winds above the inland ice of Greenland invariably blow in a general direction corresponding to that of the slope. This law of the slope winds Peary announced in 1898, though he had arrived at the conclusion some years earlier.

Table III—Evaporation at Camp Little and Lake Tahoe Compared

	Camp Little Aug. 18–Sept. 2		Lake Tahoe August
	Water	Tundra	Water
Evaporation (inches)	−0.553	−0.416	−7.330
Condensation (dew, in inches)	+0.103	+0.132	
Net balance (inches)	−0.450	−0.284	
Equivalent for 30 days (inches)	−0.90	−0.568	
Temperature (F.)	37° to 51°	46° at 2½″ 39.8° at 4′	
Mean temperature air	44.6°		60°
Average wind velocity (miles per hour)	2.8		3.2
Relative humidity (per cent)	64		25.3*

*At Reno.

The consequences which flow from Peary's law, as they apply both to the continent of Greenland and to that of the Antarctic, were first pointed out by the writer in 1910 and 1911, and the name "glacial anticyclone" has been given to the circulation above these two vast ice mantles.

The theory of the glacial anticyclone involves a large area of air drainage from high levels over the higher interior portion of each of the two continental glaciers, a sliding outward from these interior regions of the air which thus arrives at the surface, and a corresponding indraft of air at high levels to maintain this circulation. The interior region must therefore be an area of high atmospheric pressure, but it is also an area of excessive humidity owing to the ice needles of the cirri brought down with the high-level currents, and it is this ice-derived moisture which on meeting the cold surface of the glacier forms the "frost snow" that nourishes and maintains the two great refrigerating masses of our planet.

This drainage process does not go on at a uniform rate but by pulsations, or strophs, so that the characteristic weather on the slopes of the Greenland continental glacier is an alternation of calms and blizzards. These latter usually develop gradually but end suddenly; corresponding to the mechanism of the process—an outflow of air due to abstraction of heat and increased air density caused by the refrigerating surface of the glacier, and a sudden termination due to adiabatic elevation of air temperature when the down-slope winds have attained a high velocity and consequent large vertical component, due to the slopes of the ice dome.

Wind Observations in Greenland

A study of the tabulated wind observations from certain of the various meteorological stations near the coast of Greenland[12] has shown that they are chiefly of interest in their indication of the sluiceways for air within their neighborhood. Though they are so near the margins of the inland ice, at some of them the wind records show no high velocities even in the winter season. In part this is explained by the presence of pockets. The early expeditions to Scoresby Sound on the east coast, for instance, brought out the interesting fact that in this tortuous channel at far interior positions there was complete shelter from the wind. Dr. Lauge Koch has more recently shown in far northern Greenland that such pockets exist near the border of the inland ice. In them snow lies unpacked upon the ground even at the end of the winter season. It further appears from his journey across the inland ice that below the contour of 1000 meters the air is quiet because of the steep slope and the overriding of lower air layers by the down-slope winds.[13] At three stations, however—Angmagssalik, Nanortalik, and the former Norwegian station of Mygbugten[14] sluiceways are found which conduct the down-slope winds to the station. For this reason it is found possible at these stations, and these only, to secure records of the winter strophs of the Greenland anticyclone.[15]

The settlement of Holstensborg has maintained a weather station of the second order for a good many years, and through the kindness of Governor Bistrup these records, which are made by an intelligent Greenlander, have been placed at my disposal for the period of the last six years. They show wind velocities as high as nine of the Beaufort scale and that during the winter season such winds come exclusively from the easterly quadrants and are the controlling winds. During the summer season, on the contrary, the controlling winds are generally from the opposite quadrants. A study of the topography about Holstensborg reveals a broad sluiceway for winds from the easterly quadrants, so that observations of strophs should be possible at this station. In consequence, a Weather Bureau barograph and a Weather Bureau thermohygrograph have been left with Governor Bistrup, and arrangements have been made to secure records throughout the coming year. For measurement of wind velocity, precipitation, etc., the Holstensborg apparatus has been overhauled by Professor Church and Mr. Fergusson, and suggestions have been given for their further use by up-to-date methods.

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[12] Meteorologisk Aarbog (Annuaire Météorologique), Publikationer fra det Danske Meteorologiske Institut, Copenhagen.

[13] Hobbs, Glacial Anticyclones, pp. 140–142, Fig. 47.

[14] *Ibid.*, pp. 142–143, Fig. 48.

See also D. Edlund: Die neue Funkwetterstation in Ostgrönland. *Das Wetter*, Vol. 40, 1923, pp. 26–28.

[15] W. H. Hobbs: The January Storms over the North Atlantic and the Strophs of the Greenland Anticyclone, *Monthly Weather Rev.*, Vol. 54, 1926, pp. 286–288.

Observation of Strophs of the Greenland Glacial Anticyclone

While the Expedition was in Greenland during the past season there were two occasions for rather striking observation of summer strophs of the glacial anticyclone. On July 5, when our party was aboard the *Morrissey* and cruising off the coast of Greenland between Sukkertoppen and Holstensborg, a quite remarkable cloud effect was observed to the eastward. The whole eastern horizon on the near side of the coast presented the effect often observed before a thundershower, except that here the whitish gray sky extended north and south over the entire stretch of the visible coast line. Above this was the nimbus cloud, but owing to the great stretch of coast line the effect of perspective was to transform the white area into an elongated flat dome. This entire effect could be explained by cold air riding out from the interior over warmer air beneath. On many occasions when there were easterly winds the characteristic föhn clouds of mushroom shape and bluish color were seen terraced in the sky.

On August 5, the day after our arrival at the border of the inland ice, there came a stroph of the anticyclone, and as we were packing to go on the surface of the glacier, we had great difficulty in advancing against the wind. To rise from the ground with our packs was itself a difficult matter, and once on the surface of the glacier we were several times caught by this down-slope wind and bowled over into a gutter upon the surface. Professor Church has preserved the following record of this stroph:

> At noon of August 5, the day after our arrival, the barometer began falling, reaching its lowest position of 27.90 inches by 3 o'clock the following morning but recovering entirely by 3 o'clock in the afternoon and then slowly rising until noon of the 8th, when the return trip was begun. The east wind, which had prevailed throughout August 5, increased in intensity during August 6, attaining an average hourly velocity for the 24-hour period of 11.8 miles and a maximum of probably 25 miles in the gusts, the wind then dying down throughout August 7 to half the velocity, or an average of 6.6 miles.
>
> The cloudiness increased from 5 per cent on the morning of the 5th, when the stroph began, to 90 per cent at 9 o'clock that evening and continued through the 8th, with average cloudiness of 72.9, 83.3, and 96.6 per cent respectively for the three days. The cirro-stratus clouds, which developed immediately over the ice on the

5th, became lenticular with cirrus background on the 6th, attaining large size and number at the apex of the stroph.

Consequent upon the föhn character of the stroph, the mean temperature on August 6, when the stroph was most active, was 52.5° F. compared with 48.7° and 48.1° of the days immediately preceding and following.

Late on August 7, as the stroph waned, the sky suddenly became overcast and continued thus until the morning of the 9th, with very light precipitation. At the time of overcasting, a west wind was blowing aloft and a west wind also blew at the surface from midnight until morning of the 8th.

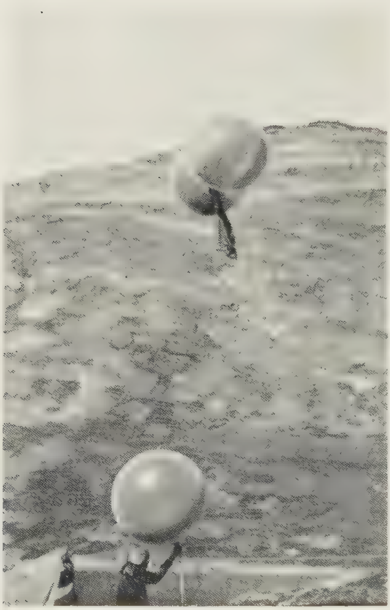

FIG. 27—The first *ballons sondes* to be sent up in Greenland. Above, two 32-cm. balloons with attached red silk parachute; below in tandem, a third 32-cm. balloon equipped with Rossby deflating device. Below, and still in tandem (not seen in view), the Fergusson meteorograph, beneath which are three 14-cm. balloons slightly inflated and in contact to serve as a raft in case the meteorograph falls in water. (Photograph by S. P. Fergusson.)

A similar phenomenon was noticed at the head of Akugdlek, August 24–27, when with a falling barometer a clear wind blew from the east, oscillating with rising barometer to the west and accompanied by heavy precipitation. In the latter case, the stroph operated nearer the sea with consequent increase in precipitation. Herein possibly lies the explanation of the anomaly that the weather at Camp Little is fair with falling barometer but stormy with rising.

WIND DIRECTION SHOWN BY TUNDRA VEGETATION

Dr. Samuelsson in an interesting and important monograph[16] has recently shown that in Greenland the direction of prevailing winds is sometimes to be read in the orientation of the tundra shrubs, which spread out upon the ground in the manner of a lady's fan. In such cases the direction of the wind is found in the bisecting line of the fan, the wind quarter being in the direction of the root.

During the trek to the inland ice attention was given to this subject, though not with any thoroughness; and at points not too distant from the inland ice margin such orientation of the tundra plants was observed and believed to be significant.

RESULTS OF AEROLOGICAL EXPLORATION

Aerological observations in Greenland have been made in the past by Drs. de Quervain, Mercanton, Stolberg, and Jost in southwest

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[16] Carl Samuelsson: Studien über die Wirkungen des Windes in den kalten und gemässigten Erdteilen (Inaug. Diss.), *Bull. Geol. Inst. of Upsala*, Vol. 20, 1926, pp. 58–230.

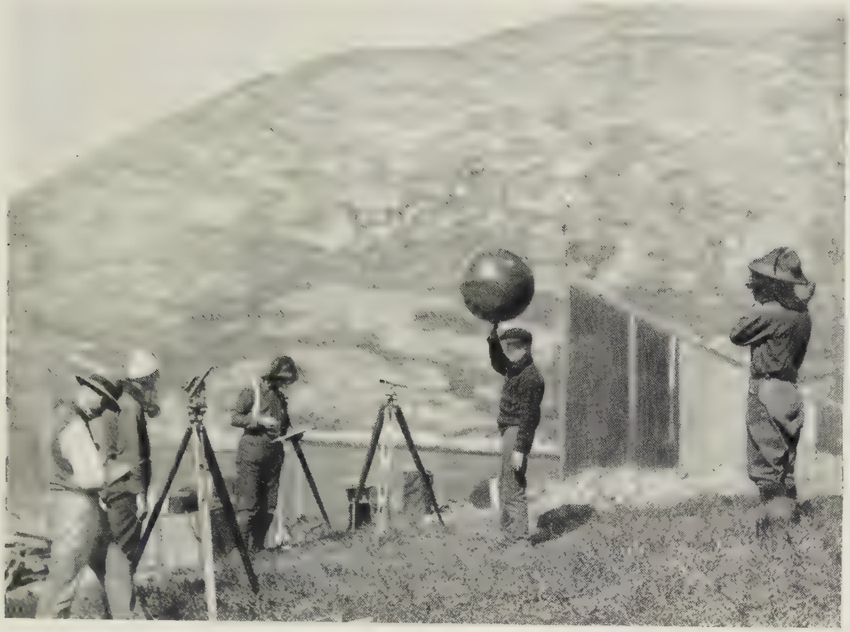

FIG. 28

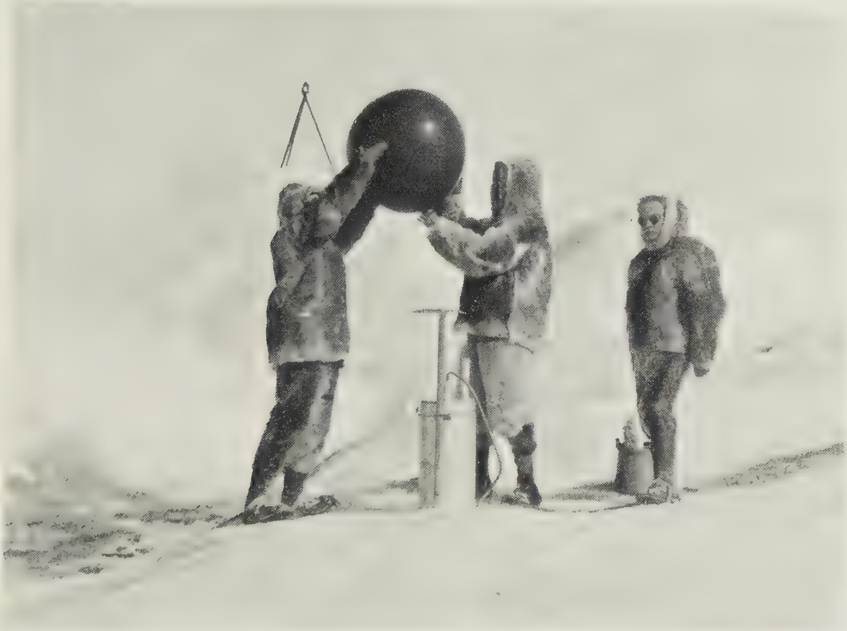

FIG. 29

FIG. 28—Preparing to send up a pilot balloon at Camp Little. In the foreground the hydrogen generator from calcium hydride. Note the head veils worn as a partial protection against the continual torment of the insects. (Photograph by L. M. Gould.)

FIG. 29—A pilot balloon ascension from the surface of the inland ice. From left to right: Church, Hobbs, Belknap. (Photograph by L. M. Gould.)

Greenland[17] and by Dr. Alfred Wegener in northeast Greenland.[18] Dr. de Quervain and his associates sent up in all about sixty pilot balloons and made three kite ascensions, the latter at Holstensborg. Of these three kite ascensions, which were to heights of 610, 550, and about 1000 meters respectively, the last mentioned was of greatest interest because it was carried out during a föhn with wind from the southeast. During the three hours and forty minutes of the ascension, the surface air temperature rose from 6.5° C. to 8.7° C., and the relative humidity fell from 45 per cent to 39 per cent.

The upper-air work of the first Greenland Expedition of the University of Michigan was carried out mainly at the base of Camp Little, where after routine had been established three pilot balloon ascensions were generally made each day by Mr. Fergusson. In all over ninety ascensions were made (Fig. 28).

Ballons Sondes Ascensions

Heretofore *ballons sondes* ascensions have been possible only in thickly settled regions where the expensive equipment after its fall is likely to be found and returned. Thanks to the deflating device recently invented by Dr. C. G. Rossby, who generously contributed three of these valves to the expedition, five ascensions of *ballons sondes* were carried out at Camp Little with the use of the Fergusson meteorograph, and four of them were successful. One of the meteorographs was first lost but was afterwards found and has supplied a record to the height of about 8000 meters. These are the first *ballons sondes* ascensions ever to have been made in Greenland (Fig. 27).

Pilot-Balloon Ascensions from Near and Over the Inland Ice

For all balloon ascensions of our Expedition the hydrogen was generated from calcium hydride in a generator built from plans supplied by Dr. Harold Sverdrup, and this modern method of securing hydrogen made it possible to carry out ascensions at and over the inland ice one hundred miles inland. Over the inland ice one of the ascensions was followed with the meteorograph to the height of about 5500 meters. These are the first ascensions by pilot balloon known to have been made either very close to or over the inland ice of Greenland or the Antarctic (Fig 29).

Throughout the season Mr. Fergusson made regular observations of clouds, and all ascensions were carefully checked by comparison

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[17] Alfred de Quervain and P. L. Mercanton and others: Ergebnisse der Schweizerischen Grönland expedition (Résultats scientifiques de l'Expédition Suisse au Groenland) 1912–1913, *Neue Denkschr. Schweiz. Naturforsch. Gesell.*, Vol. 53, 1920.

[18] Alfred Wegener: Drachen-und Fesselballonaufstiege ausgeführt auf der Danmark-Expedition 1906–1908, *Meddelelser om Grønland*, Vol. 40, 1909, pp. 1–75.

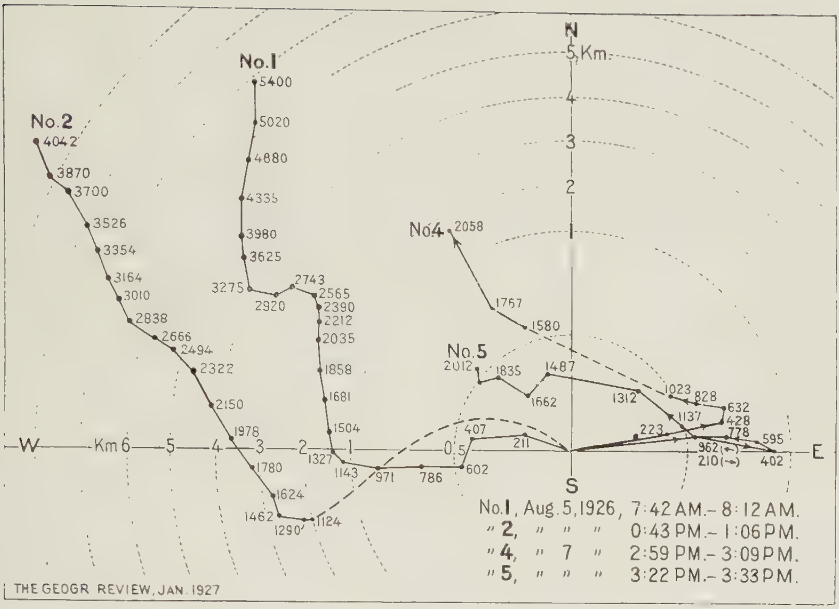

FIG. 30

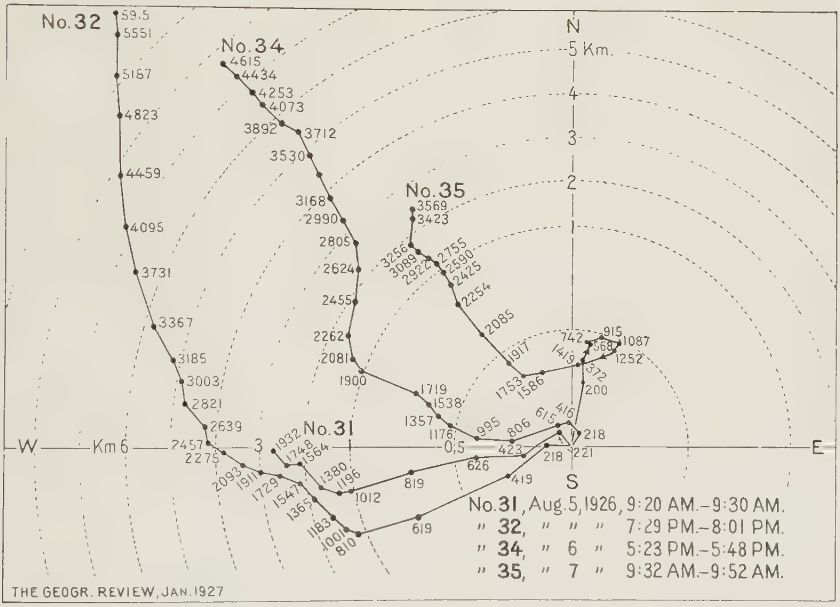

FIG. 31

FIG. 30—Plan of pilot balloon ascensions 1, 2, 4, and 5. Ascensions 1 and 2 from Camp Cooley near the margin of the inland ice (Fig. 4) on August 5, 1926. The elevation of Camp Cooley is about 300 meters. Ascensions 4 and 5 from the surface of the inland ice on August 7, 1926.

FIG. 31—Plan of pilot balloon ascensions 31, 32, 34, and 35 at Camp Little. Ascensions 31 and 32 on August 5, 1926: Ascension 34 on August 6 and 35 on August 7.

with these cloud observations. The following quotations are from his preliminary report:

> Assuming that during the summer the bottom of the stratosphere is in this region about 9000 meters above sea level, the highest velocity of the cirrus recorded was 20 meters a second, and the average of all observations is probably less than one half that figure, or about one half the velocity observed in lower latitudes. If the upper winds tend to blow toward the ice cap, as indicated by earlier observations of cirrus in Iceland, there should be an acceleration of the prevailing westerly winds on the west coast and a decided increase of velocity with increase of height; this evidently does not occur in summer. It is hoped that the cloud observations that were to be made the past summer by Dr. Thorkelson in Iceland will throw further light upon this question.
>
> The vertical gradients of temperature shown by the ascensions of *ballons sondes* appear to be of the same character as those observed elsewhere. Lapse rates of 0.6° F., 0.7°, and 0.8° per 100 meters were obtained. Strong convectional currents, indicated by massive cumulus clouds, ascended frequently and extended to considerable heights, although no thunderstorms were observed.
>
> From the few records of pilot balloons so far evaluated, as well as from the observations of clouds, it appears that the changes of direction of the winds resemble those occurring at lower latitudes, in that the directions become more and more frequently from some westerly point as the height increases. The proportion of winds from easterly directions at the cirrus level appears to be slightly greater than is the case in eastern America, but it is possible that this excess may be normal wherever the velocities are as low as those recorded in western Greenland.
>
> The two groups of ascensions made on August 5–7 at Camp Little and over the ice cap show nearly the same changes of direction and velocity of wind at approximately the same heights; and while it must be emphasized that the data of ascensions not yet computed cannot be evaluated accurately by inspection, it appears from examination that the southeasterly winds long ago observed at the surface extend to and prevail at heights exceeding 1000 meters, becoming gradually southerly or northerly and finally westerly before the stratosphere is reached (Figs. 30 and 31).[19]
>
> The two groups of ascensions referred to were made during the same type of weather, hence they may not represent the average or a prevailing condition.

The computations necessary to the full study of the ascensions—more than ninety—carried out by the Expedition are now being made by Mr. Fergusson, and they will be published elsewhere.

Survey, Geological and Tidal Studies and Radio

In addition to the cartographic data which appear upon the official maps of that part of the Holstensborg district which we have examined (Fig. 2), Nordenskjöld has a sketch map, based upon his exploration in the summer of 1909,[20] delineating a route to the inland ice—an ancient caribou hunter's trail across the tundra—which we have largely followed. It is a pleasure to bear witness to the accuracy of Nordenskjöld's observations, something quite remarkable when one considers the brief time which he was able to devote to this particular

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[19] Cf. Hobbs, The Glacial Anticyclones, pp. 76–77; also *Proc. Amer. Philos. Soc.*, Vol. 54, 1915, p. 214, Fig. 7.

[20] Nordenskjöld, Einige Züge der physischen Geographie, p. 433.

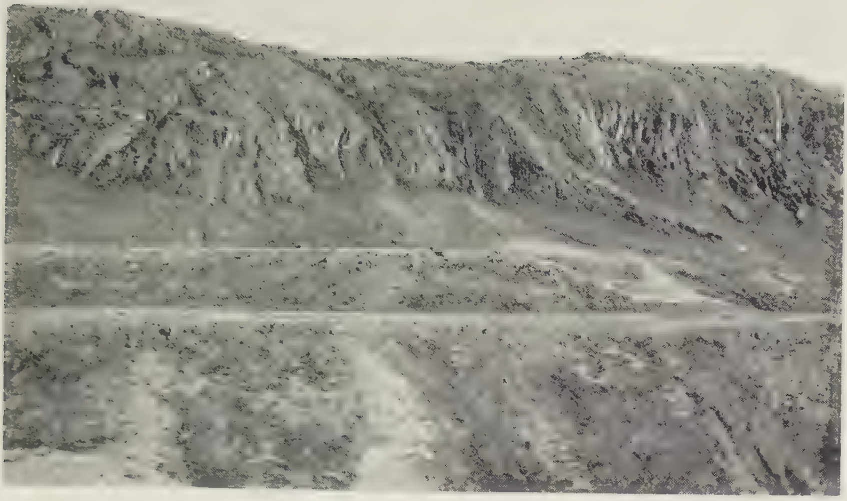

FIG. 32

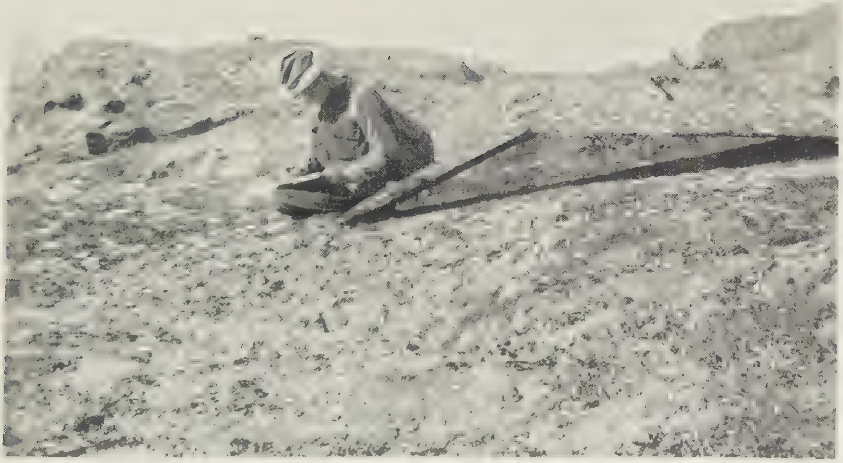

FIG. 33

FIG. 32—A detail view of two of the terraces shown in Figure 9. A special study of terraces has been made by the Expedition. (Photograph by L. M. Gould.)

FIG. 33—Remarkable example of insolation from the high plateau east of Camp Little. The slab of gneiss which had been raised up from its bed is about eight feet in length. Similar bendings up may sometimes be observed in cement sidewalks during the summer heat. (Photograph by W. H. Hobbs.)

district. As he makes clear, the region is one of marked relief deeply incised by fiords and covered with numerous lakes in the plateau levels.

With the assistance of other members of the Expedition Mr. Belknap has completed the triangulation of an area of about 1000 square miles, lying mainly within the outer belt of high and rugged topography and largely to the eastward of Camp Little. This has required the measurement of a preliminary base line and the occupation by transit of a score of high stations at which bamboo poles carrying flags had first been set up. These stations for the most part had altitudes varying from 1000 to more than 4000 feet. Plane-table maps have been made of the shores of Maligiak Fjord and of the vicinity of Camp Little (Fig. 3). A line of levels from tidewater to the margin of the inland ice has been begun and already carried some distance to the eastward of Lake Taserssuak. This work is to be resumed next season, and it is hoped to continue the profile up onto the inland ice to the end that barometric readings upon the glacier may be properly interpreted.

Although the sculpturing agent which has largely determined the form of the relief within the Holstensborg district has been glacial ice, the lines within the pattern displayed are elements of a fracture network outlined by nearly vertical planes comprised within a very simple system—a rectangular checkerboard design (Figs. 23 and 26.) The bounding planes of the units are in most instances clearly faults, and these stand nearly perpendicular to the surface. The master lines are nearly parallel and perpendicular to the meridian, which directions are also followed by the course of the principal fiords that appear on the map (Fig. 2). The escarpments presenting major features in this pattern are being entered on the map that is in preparation by Mr. Belknap, who is making a special study of the structure.

Though the coastal region in this part of Greenland is one of great subsidence, as is testified to by the deep fiords penetrating far into the country, later repeated uplifts are recorded as well by marked terraces represented by a number of stages. While these are most frequently found cut in the heavy deposits of glacial clay (foreground of Fig. 20), many are leveled off in the hard crystalline rock (at the left of Fig. 20 and at many places in Fig. 22). Farther back in the hinterland the terraces take on a different aspect and are to be correlated with successive blockings and unblockings of drainage lines by a low-level tongue that formerly issued from the inland ice (Figs. 9 and 32). Professor Gould has made a special study of the terraces observed by the Expedition. Nordenskjöld has devoted an important section of his report to the terraces and particularly the coastal platform, but he has given no very clear pronouncement with respect to origin.[21]

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[21] *Ibid.*, pp. 134-141.

A standard tide gauge was loaned the Expedition by the Superintendent of the Coast and Geodetic Survey, and this was early set up at Camp Little, though it offered some difficulties because of the large range of the spring tides—over twelve feet. A tube of sufficient length, however, was constructed by Mr. Belknap from our scant supply of lumber, and after various adjustments had been made by Mr. Fergusson, who replaced the stiff original markers with the Weather Bureau type of pen, some quite satisfactory records were produced which are to be turned over to the Coast and Geodetic Survey for study.

Space will not permit discussion here of the interesting results obtained at the wireless station. All previous work with radio in Greenland has been limited to the seacoast stations of the Danish government, which all employ the long wave lengths. John L. Reinartz, when operating for the Macmillan Expedition of 1925, set up a short-wave station on shore near the ship when in the Cape York district and maintained it for a brief period.

As a first experiment our 35-foot mast was set up, and a station was established within the rock amphitheater in which Camp Little is located, but with only meager results. The station was then removed to the summit of a projecting headland, Radio Point, at the southern entrance to University Bay. Here the Reinartz rule that rising land masses about the station shall not project above an 18° arc with the horizontal was met upon all sides but the southeast. At once the new station established connection with very remote points. In fact, conditions here approached the ideal.

PREPARATIONS FOR THE EXPEDITION OF 1927

In preparation for the Expedition of 1927 supplies have already been taken to Camp Little where they are in storage. These include considerable equipment, some of which was used the present year, and also provisions. Lumber was taken from Canada and a small storehouse constructed. About 100 gallons of aviation gasoline and 50 gallons of fuel gasoline are now stored in steel drums at Camp Little. Two Chestnut canoes and a dory and valuable instruments of precision are in the care of Governor Bistrup at Holstensborg.

During the present season 20 gallons of kerosene, bamboo poles to be used as markers upon the inland ice, furs, rope, and certain other equipment were packed in to Camp Cooley and cached there near the margin of the Otto Nordenskjöld Glacier. Arrangements have been made with Governor Bistrup to have 200 pounds of pemmican, over 100 pounds of other nonperishable provisions, and certain equipment all taken in by dog sled during the late winter before the lakes have opened or the ground has become bare of snow.

CHAN-CHAN: CAPITAL OF THE GREAT CHIMU*

Otto Holstein

A FEW hundred miles northwest of Lima and about four miles west of the city of Trujillo lie the ruins of Chan-Chan, probably one of the greatest cities in the western hemisphere in pre-Columbian times. It was the capital of the Great Chimu, a ruler who extended his sway for five or six hundred miles along the Peruvian coast and who built monumental structures in which are preserved the records of a resourceful and once powerful race. But of it we know comparatively little. The Incan civilization, in its heyday when the Spaniards arrived, has dwarfed interest in its predecessors in the Central Andes, both in the mountains and on the coast. Chan-Chan has been known from the earliest descriptions of the Spanish *conquistadores* and has attracted some scientific notice, but systematic study is urgently needed before earthquakes and rains and treasure seekers complete their work of destruction. The writer's purpose in describing the present state of the ruins and publishing the accompanying photographs is to call attention to this need. It was in particular brought home to him by witnessing the disastrous effects of the rains of March, 1925. The setting and relationships of the area offer much of geographical as well as archeological interest.

SITE OF THE CITY

The ruins of Chan-Chan cover an area of about eleven square miles, and the entire city was enclosed within a high wall. If we assume that the whole of the site was occupied at one time, it may have had a population of two hundred thousand or two hundred and fifty thousand souls, as Montesinos and other early historians concluded. We know, however, that the tendency in such estimates is toward exaggeration, so that the population may well have been smaller. Wiener,[1] after a study of the site, thought that the cultivated area was ten times as extensive as the cultivated area about Trujillo today and that the population was possibly three times as great. The city stands in the midst of a fertile and well-watered section of the coastal plain, on an imposing site—the blue Pacific on the one hand and the great wall of the Andes on the other. It has an equable climate, sunny, but cooled for almost the entire year by a southerly breeze. Chan-Chan means in the Chimu tongue "Sun-Sun."

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*The author wishes to acknowledge his indebtedness in the preparation of this paper not only to the authors of the works cited but to his personal friends, especially Doctor Ricardo Rivadeneira, Señor Garrido, and the Reverend Father Antonio de Alcelay. These have supplied important papers, notes, and manuscripts from the local archives and have offered other valuable information.

[1] Charles Wiener: Pérou et Bolivie, Paris, 1880, p. 542.

The region is practically rainless under normal conditions.[2] The Moche River descends from high Andean sources as a full-channeled stream for part of the year, and this made possible the building of a widely ramifying and scientifically constructed series of irrigation canals. Not only that, but the Chimu peoples knew how to construct reservoirs to conserve the water for the drier season. Under such conditions it was possible to raise several crops a year. We may assume that the whole region was intensively cultivated. "The marks

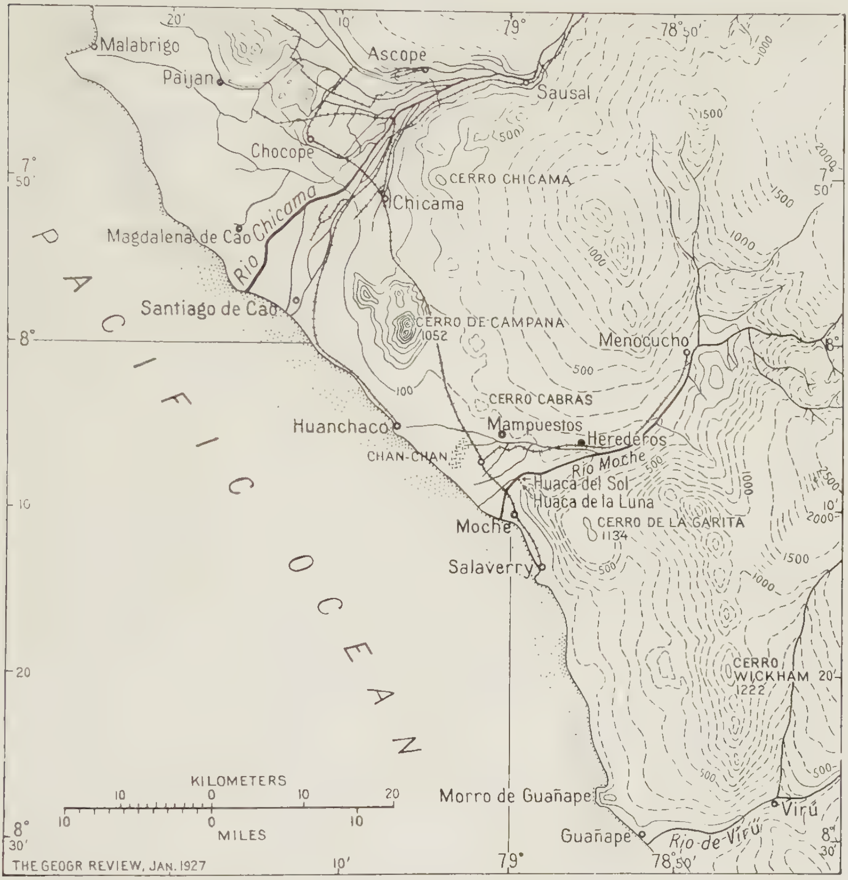

Fig. 1—Map of the vicinity of Trujillo showing the site of Chan-Chan. Drawn from the compilation prepared for the Trujillo and Piura sheets of the American Geographical Society's Millionth Map of Hispanic America. Scale 1:0,000,000. For general relations see the map, Figure 4.

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[2] See the note "The Extraordinary Rains and Floods in La Libertad, 1925," elsewhere in this number of the *Review*.

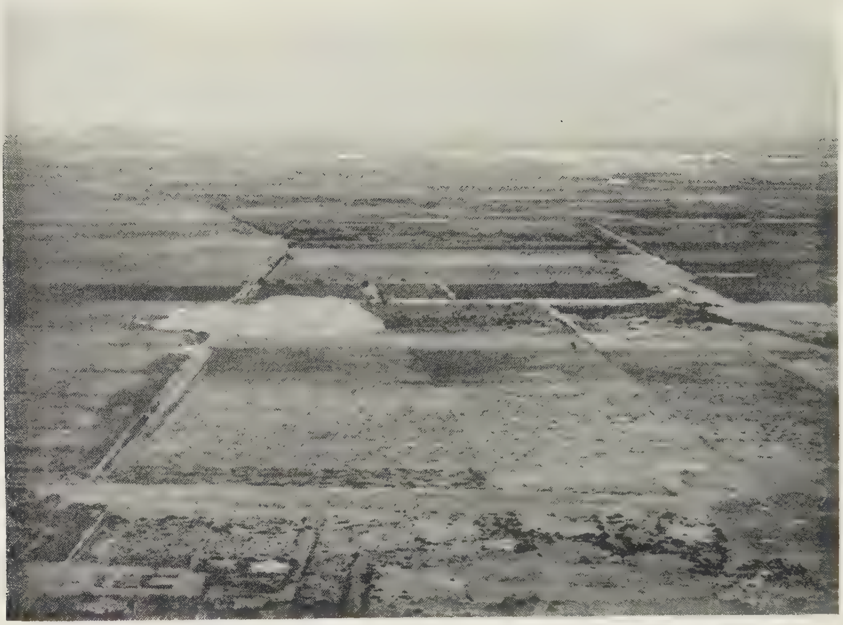

FIG. 2

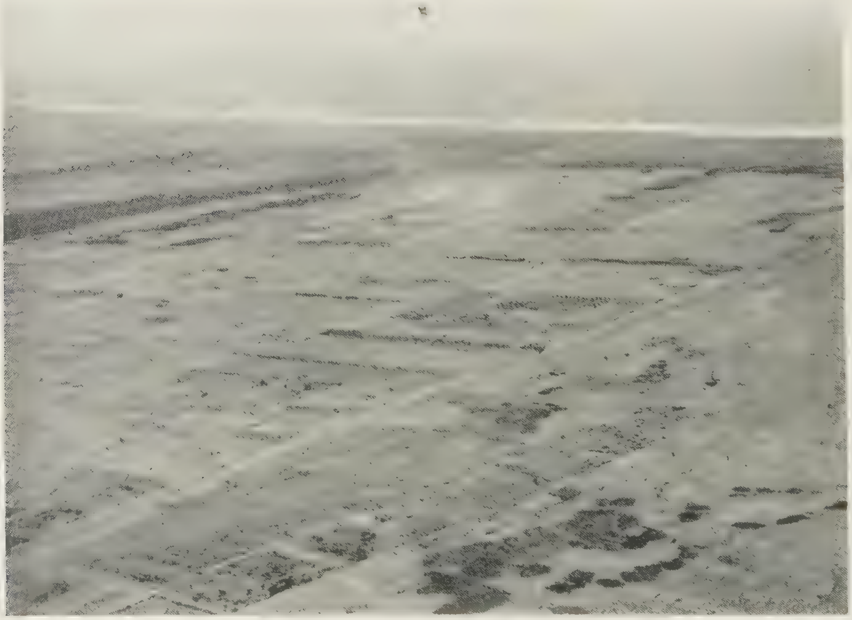

FIG. 3

FIG. 2—Part of the ruins of Chan-Chan. City of Trujillo in the distance. The *huaca* Esperanza in the foreground.

FIG. 3—Chan-Chan looking toward the Pacific.

of the furrows are even to this day visible," says Rivero,[3] and one may make out just such marks today (Fig. 25). They are precisely like those made by the plow and are found in the fields in the neighborhood of the ruins. In addition to the immediate site the valleys north and south along the coast for hundreds of miles were tributary to the Great Chimu and were probably drawn on and exploited after the immemorial practice of expanding empires.

The Coast Valleys of Peru

To understand the importance of the site and its place in the culture of its time we may well take a brief excursion into the history of the coastal peoples, keeping in mind the well marked physical environment in which that history unfolded. Not only did the geographical features of the region leave their impress upon the material culture; they at the same time limited the scope of activities of the coastal peoples and in the end had much to do with their final conquest.

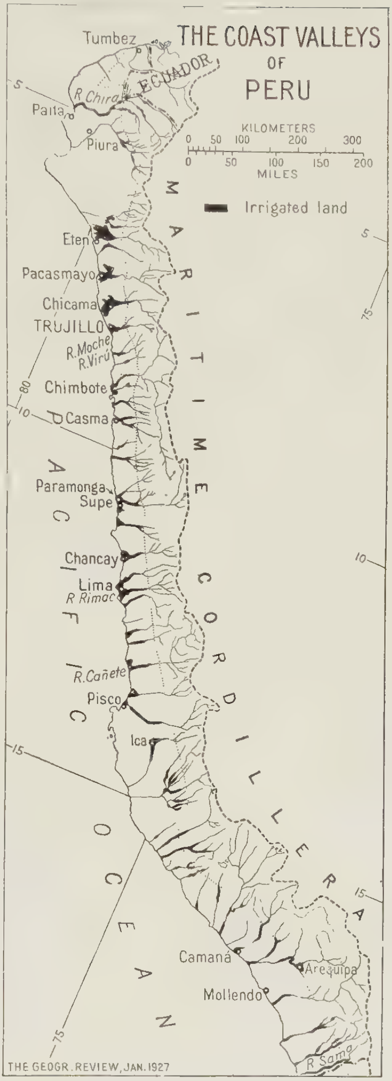

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Fig. 4—Map showing the valleys and irrigated land of the Peruvian coast. The dotted line between the crest of the Maritime Cordillera (shown by a dashed line) and the shore line delimits the mountain zone of annual rains and the coastal zone of rains at intervals of several years. Scale approximately 1:13,500,000.

The coast of Peru is marked by a variety of terraces, alluvial fans, widespreading deltas, narrow coastal plains, and uplifted wave-cut shelves that result in a patchy distribution of arable land. There are about thirty main rivers that come down from the Andes flowing through alluvial valley floors and debouching upon the widespreading alluvial fans and deltas they have built up.

From the human standpoint it is the distinguishing feature of the cultivated and watered tracts that they are relatively small in size and separated from each other by wide expanses of desert or arid mountain spurs and isolated ranges. The result of these physical circumstances is well marked in the history of the coastal peoples. At the time of the Inca conquest, just before the coming of the Spaniards, four major coastal states had come into being, after a history of conquest and re-conquest about which we know but little today and shall know little until extensive archeological work has been done. On the north, from Tumbez to Casma, the country was under the rule of one known to the Incas as Chimu-Capac, or the Great Chimu. Farther south the Rimac valley at the present site of Lima and other valleys were under another ruler or chief. Still farther south was a third, and the southernmost valleys of Peru, including the regions of Ica and Pisco, were under the rule of a fourth chief.[4]

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[3] M. E. Rivero and J. J. von Tschudi: Peruvian Antiquities, transl. by F. L. Hawks, New York, 1853, p. 264; quoted from Rivero's earlier work of 1841.

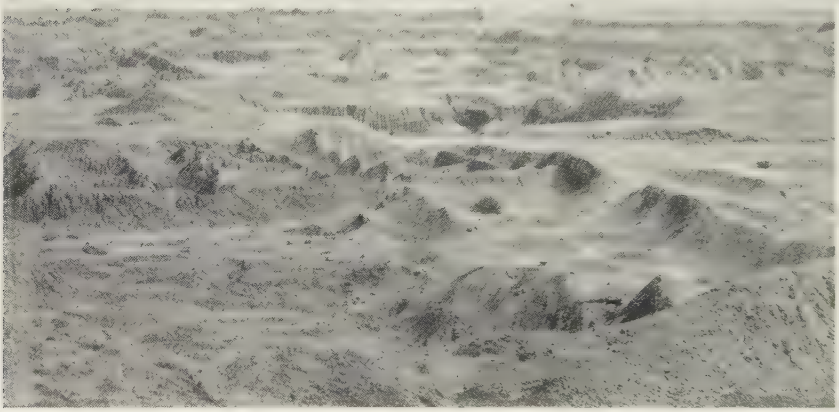

FIG. 5—General view of Chan-Chan looking seaward (west).

ANCIENT CULTURES

Hrdlička has given a description of the material culture.[5] The houses were built of reeds or of small uncut stones or sun-dried bricks or blocks. Their larger structures known as *huacas* served a double purpose—as places of ceremony and of burial. The arts of weaving, using the native cotton and llama wool, and of pottery making were well advanced. Both the textiles and the decoration of the pottery show a considerable variation from place to place and from time to time. To a limited degree the people knew how to work copper, silver, and gold, though they had few or no stone implements. They had copper axes and hoes, wooden clubs, copper knives, slings and bows-and-arrows, as well as metal or stone maces that served as weapons. They had needles of bone or cactus spine; and the fishermen had nets and sinkers, reed boats or *balsas*. They had practically no precious stones; but they used beads, seeds, feathers, yarn, and cloths as well as metal objects for personal decoration. In their pottery they made frequent use of molds and stamps "and were masters at imitating natural objects and animals as well as man."

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[4] P. A. Means: A Survey of Ancient Peruvian Art, *Trans. Connecticut Acad. of Arts and Sci.*, Vol. 21, 1917, pp. 315–442; reference on p. 329.

[5] Aleš Hrdlička: Anthropological Work in Peru in 1913, with Notes on the Pathology of the Ancient Peruvians, *Smithsonian Misc. Colls.*, Vol. 61, No. 18, Washington, 1914.

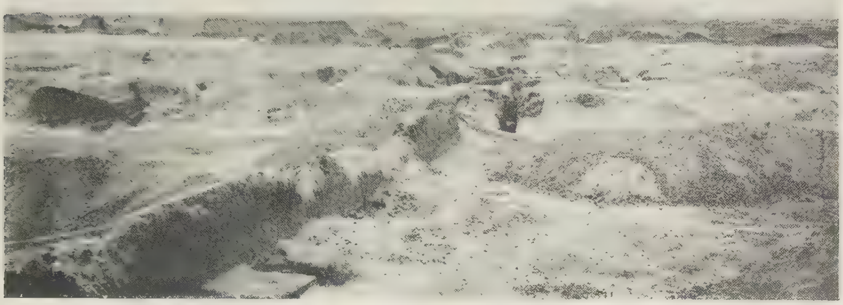

FIG. 6—General view of Chan-Chan looking northeast. The *huaca* Esperanza in the distance.

Their pottery in particular furnishes valuable evidence of the cultural and geographical relationships of these people. Several strata are recognizable. In the northern coastal region, with which we are here concerned, the earliest stage is known as proto-Chimu. It is a red-and-white ware and is identified by its antiquity and stylistic uniformity and purity. Kroeber[6] considers its technical and aesthetic qualities such as could only be produced by a population prosperous for some time and possessed of economic surplus and leisure. Like the proto-Nazca culture farther south, it is known only in its full bloom. Kroeber draws the general conclusion that the proto-Chimu, for all its aesthetic superiority, remained a local style occurring but sparingly in adjacent coastal regions. It seems to have developed at a time when there were limited communications between the coastal groups and probably when the people were divided into restricted political units. On historical grounds Means dates this epoch as prior to about 500 A. D.[7]

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[6] A. L. Kroeber: The Uhle Pottery Collections from Moche and the Uhle Pottery Collections from Supe, *Univ. of California Publs. in Amer. Archaeol. and Ethnol.*, Vol. 21, 1925, pp. 191–264.

[7] P. A. Means: An Outline of the Culture-Sequence in the Andean Area, *Proc. 19th Internatl. Congr. of Americanists Held at Washington, Dec. 27–31, 1915*. Washington, 1917, pp. 236–252.

The succeeding period shows the penetration of Tiahuanacan influence. Spreading from the Titicaca region this megalithic culture gave a characteristic stamp over a wide area (see Fig. 22). A period of debased types followed, and then local styles reappeared, notably in the red-white-black ware and in the Chimu ware, the last finally showing a minor Incan influence.

ORIGIN OF THE RACE

All who have written of the coastal peoples assume that earlier primitive periods of development must have existed, yet no traces have so far been found. One of the outstanding objects of archeological research in Peru today is to ascertain whether excavations in the coastal area will not disclose a center of culture from which the proto-Chimu and proto-Nazca were derived. Failure in this attempt would apparently leave no other hypothesis than that of direct importation of ready-made culture from farther north, presumably from Central America.

Anatomical and particularly cranial studies show that the Peruvian coast for a space of about six hundred miles was peopled by a well marked physical type of Indian.[8] "The coast population . . . was, barring some intrusions from the mountains, of the Maya type and same derivation."[9]

More light on the origin of the race might be shed by a study of the philology. The inhabitants of Chan-Chan spoke a language known as Yunga (or Yunca) or Mochica of which today vestiges survive in the vicinity of Eten. In the year 1644 Fernando de la Carrera wrote a grammar, "Arte de la lengua Yunga," only three copies of which are known to exist. It was reprinted in a limited edition in 1880 under the care of Cárlos Paz Soldan, and, based on this, a version by Federico Villareal of the University of San Marcos was published in 1921.[10] Dr. Villareal includes a list of Mochica words of current speech collected from an inhabitant of Eten. Squier says "The inhabitants of the Indian village of Moche still speak in confidential intercourse, the ancient language of the Chimus, which, from all I can learn, is identical with that spoken in the village of Eten . . . "[11]

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[8] Hrdlička, *op. cit.*

[9] Aleš Hrdlička: The People of the Main American Cultures, *Proc. Amer. Philos. Soc.*, Vol. 65, 1926, pp. 157–160; reference on p. 159.

[10] Fernando de la Carrera: Arte de la lengua Yunga de los valles del Obispado de Trujillo con un confesonario y todas las oraciones cristianas y otras cosas, Lima, 1644; 2nd edit., Lima, 1880.

Federico Villareal: La lengua Yunga o Mochica: Segun el arte publicado en Lima en 1644 por el licenciado D. Fernando de la Carrera, Lima, 1921.

Attention was called to these works by Prof. M. A. Saville. Copies of the 1880 and 1921 volumes are in possession of the Museum of the American Indian, Heye Foundation, New York.

[11] E. G. Squier: Peru: Incidents of Travel and Exploration in the Land of the Incas, New York, 1877, p. 160.

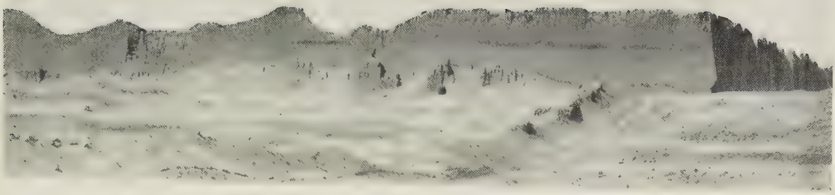

FIG. 7

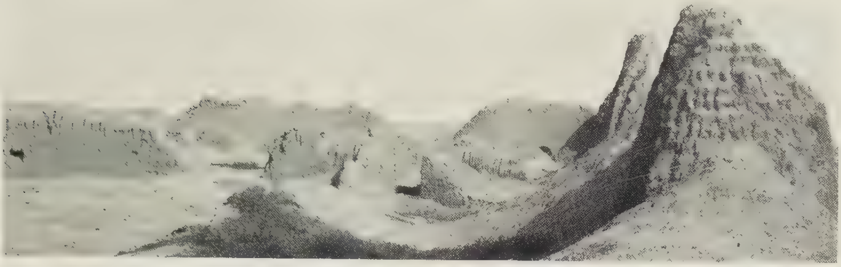

FIG. 8

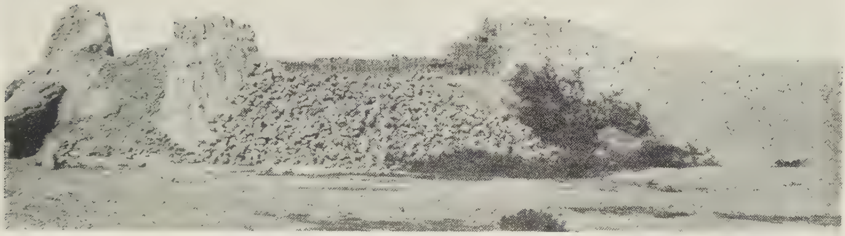

FIG. 9

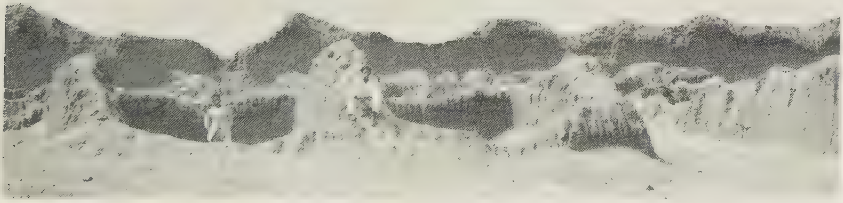

FIG. 10

FIG. 7—Fortifications, Chan-Chan. The walls here are from 50 to 60 feet high.
FIG. 8—Walls of buildings at Chan-Chan. Note the reed protruding from top of wall at right.
FIG. 9—Part of the fortifications of Chan-Chan.
FIG. 10—House ruins at Chan-Chan.

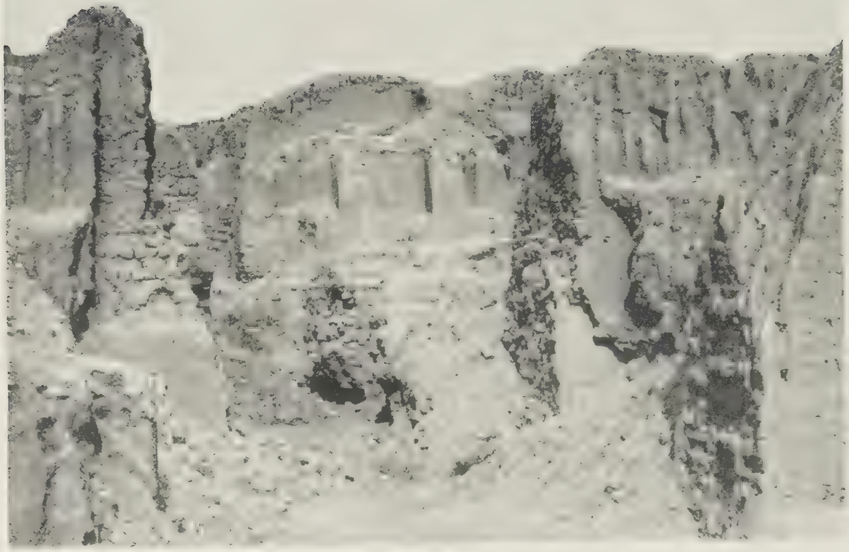

FIG. 11

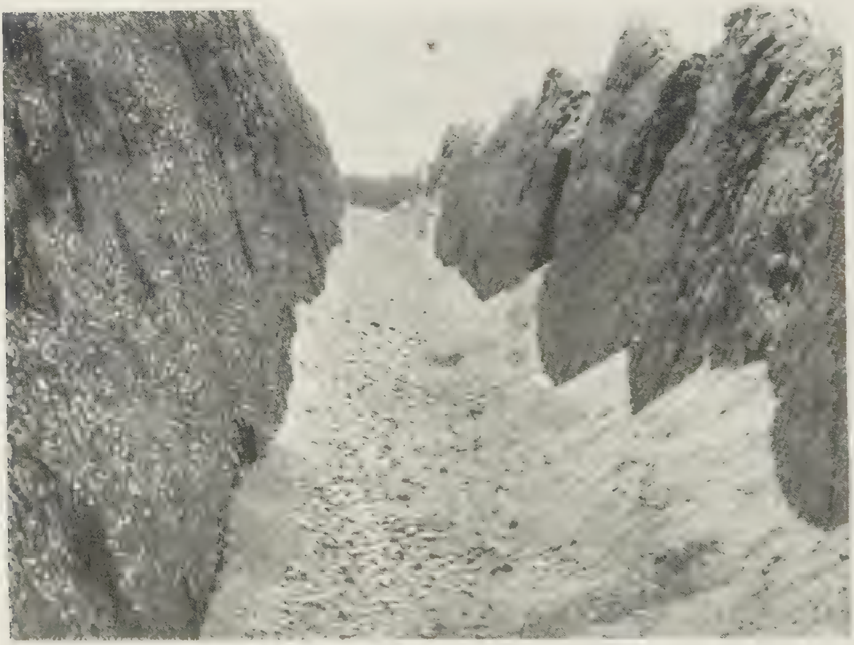

FIG. 12

FIG. 11—An interior view in the palace of the Great Chimu.
FIG. 12—A street in Chan-Chan.

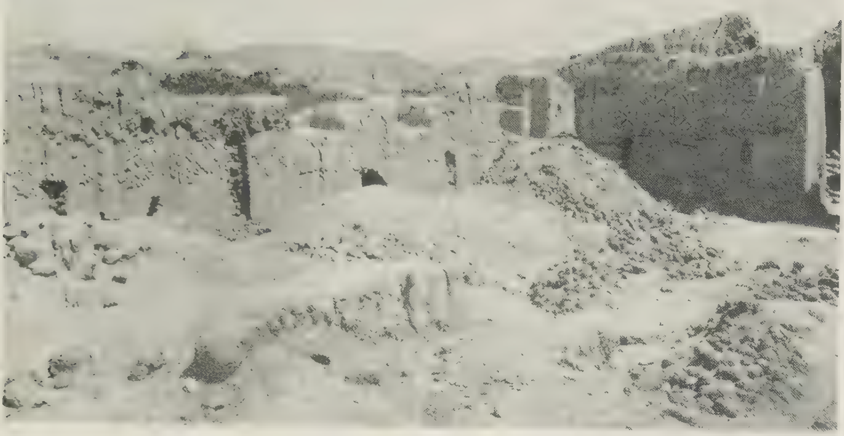

FIG. 13

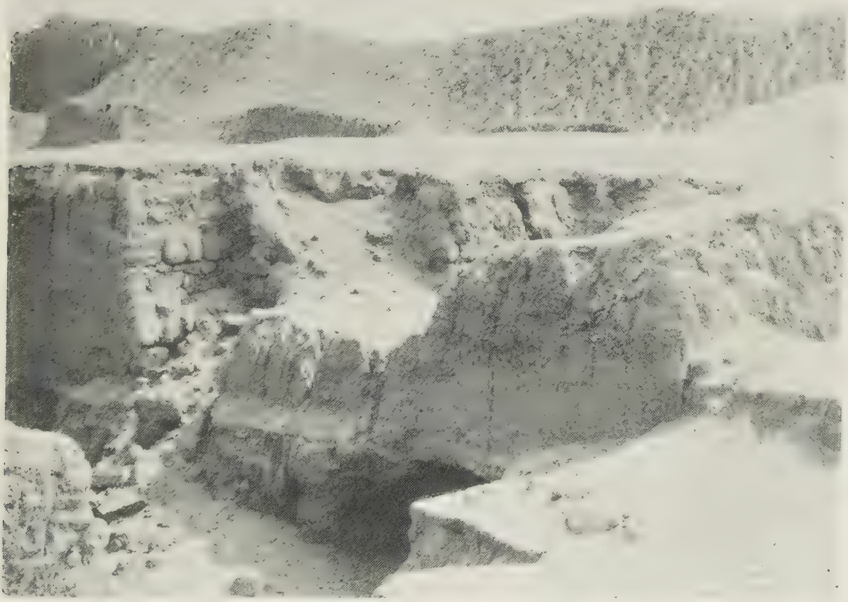

FIG. 14

FIG. 13—An interior view of the palace of the Great Chimu, taken before the rains.
FIG. 14—Ruins at Chan-Chan. Note checker-board motif on wall in center.

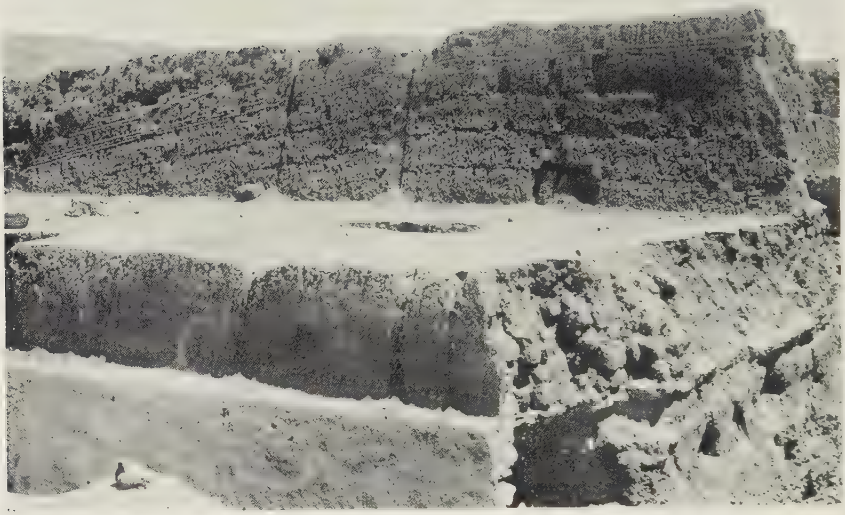

Fig. 15

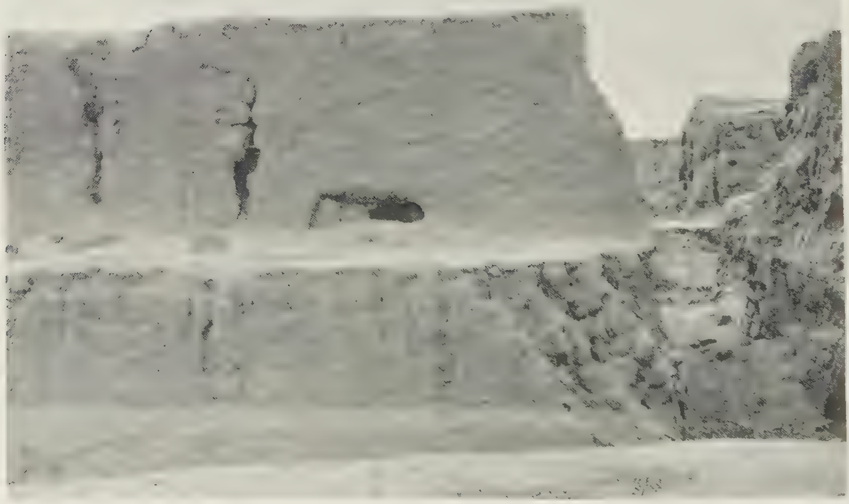

Fig. 16

Figs. 15 and 16—A decorated ramp at Chan-Chan. These pictures were taken respectively before and after the rains of March, 1925.

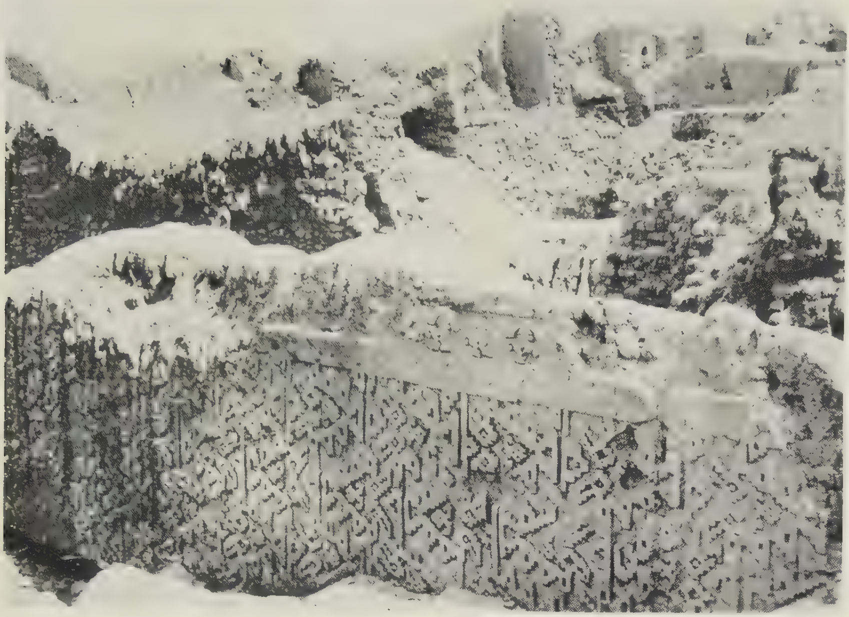

Fig. 17

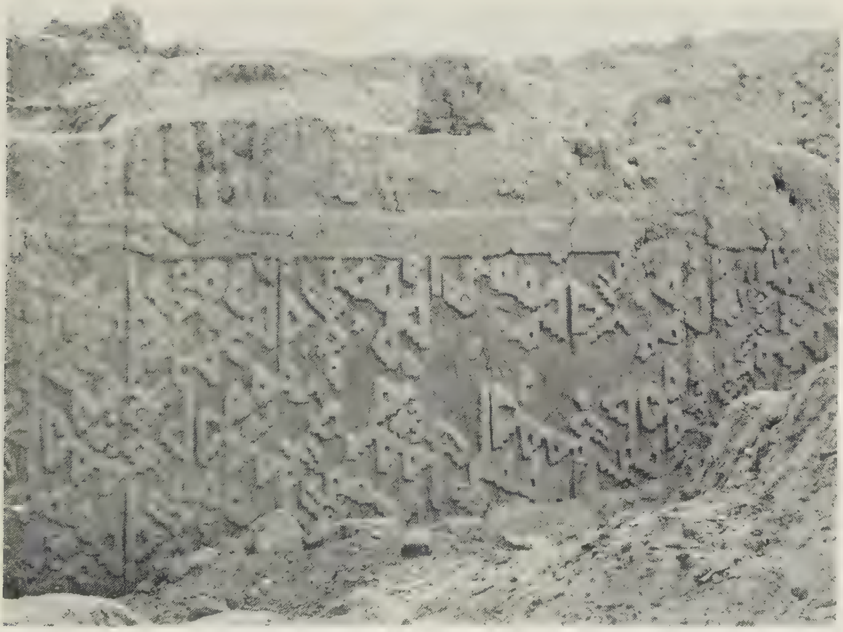

Fig. 18

Figs. 17 and 18—An interior view in the palace of the Great Chimu, taken respectively before and after the March rains. The top frieze of legendary animals in Figure 17 has now entirely disappeared.

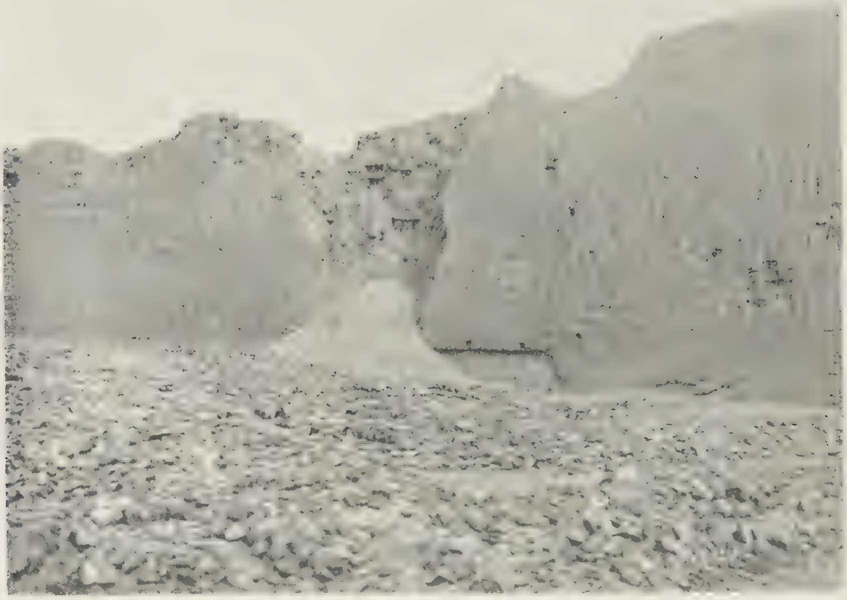

Fig. 19

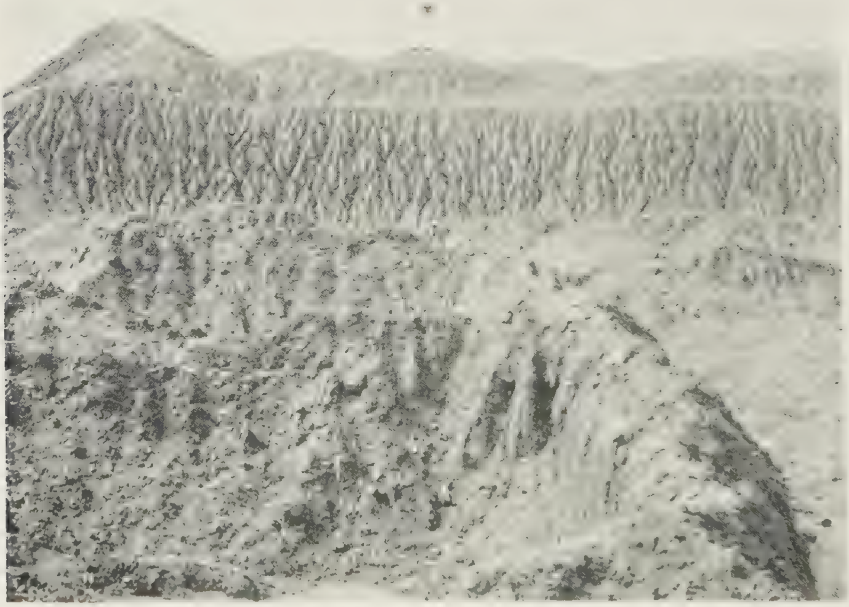

Fig. 20

Fig. 19—Part of the defensive walls at Chan-Chan.
Fig. 20—Ruins at Chan-Chan showing damage caused by erosion.

History and Legend

Historical evidence gives support to archeological conclusions regarding the civilizations of the Central Andean region. Means has sifted the evidence. In a recent paper he discusses the merits of the chief sources, including Montesinos.[12] Important checks on the much disputed work of that writer are the chronicles of Fathers Miguel Cabello de Balboa and Antonio de la Calancha, written respectively in the latter half of the sixteenth and the first half of the seventeenth centuries. Both afford interesting particulars of the coast civilizations, and both lay stress upon the fact that the coast population after it had increased to a certain point was hard put to find enough food. Cabello attributes the folk movements on the coast chiefly to the need of more land. Cabello is the only authority that gives any tradition respecting the origin of the coast people. He narrates the legend of the people of the Trujillo region.

In the dim past their ancestors came from the north by sea, arriving by means of a great fleet of *balsas*, or rafts. The legend describes the newcomers as highly organized, with all the distinctions and services of a court. Upon the death of the ruler there were eleven successors, at the end of which time the country was formed into a republic in which state it existed for a long time until the powerful chief Chimu-Capac in the Chicama valley came into power. He extended the borders of his dominion, making vassals of conquered peoples and putting over them governors responsible to him. Thus both north and south the dynasty of the Chimus exacted tribute, and by this means and the development of their own particular province the Chimu kings built up a state of magnificence and ceremonial that no doubt augmented in a moral way their material power. Archeological records bear this out. The early coast pottery portrays scenes from a well developed court life, and its importance is just in proportion to its realistic character. It had not yet become sufficiently generalized or conventionalized to obscure the life and history of the people. The tendency toward conventionalization makes such evidence of less and less value as time goes on. Thus the Tiahuanacan of the highlands had advanced so far in the process of conventionalization that it has less documentary value.

It is hardly necessary to say that the legends and traditions are not to be accepted in their entirety. However, they give an approximate idea of the age to which they relate and the source and the history of the peoples concerned, and that they are authentic in parts is well shown by their references to some of the physical features of today—the terrible floods that were followed by pestilence and hunger, as recited by Cabello de Balboa.

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[12] P. A. Means: A Study of Ancient Andean Social Institutions, *Trans. Connecticut Acad. of Arts and Sci.*, Vol. 27, 1925, pp. 407–469. See also the volume on Montesinos, "Memorias antiguas historiales del Peru," in the Hakluyt Series (Ser. 2, Vol. 48, London, 1920) translated and edited by Means.

With the coming of the Incas the history of the coastal region took on new significance. If the Chimu rulers had advanced into the Andean region before the Inca period, which is the view of the historian Montesinos, these incursions were stopped by the Incas by means of fortifications on the west, just as similar fortifications in key situations mark the outposts of empire on the eastern border of the cordillera during the Inca and pre-Inca periods. When the Incas entered on their policy of expansion the Chimus, encouraged by the ease of life in their fertile valleys and the tribute due their earlier conquests, appear to have lapsed into a state of laxity and sluggishness. The decisive battle between the two Empires was fought at Parmunca (Paramonga, see Fig. 4). This Chimu fortress was on the same general lines as Chan-Chan, the same stuccos, paintings, and the like. Of its three parallel lines of adobe walls the exterior measured seven hundred and the inner six hundred feet in length, and they had salients that extended ninety feet forward. Failing in direct assault upon the stronghold, the Inca took his position on the high grounds and, in the foothills near Chan-Chan, possessed himself of the ravines and river courses that supplied the plain with water. There, by constructing dams and diverting the streams, he brought about a terrible drought; he also threatened to deprive the Chimus of the light, as he had deprived them of water, if they did not capitulate. Their capital was destroyed, and many of the people were transported to other provinces, the remnants of population being left with local chieftains as governors, tributary to the Inca. These events took place about the year 1400, or 130 years before the coming of the Spaniards.

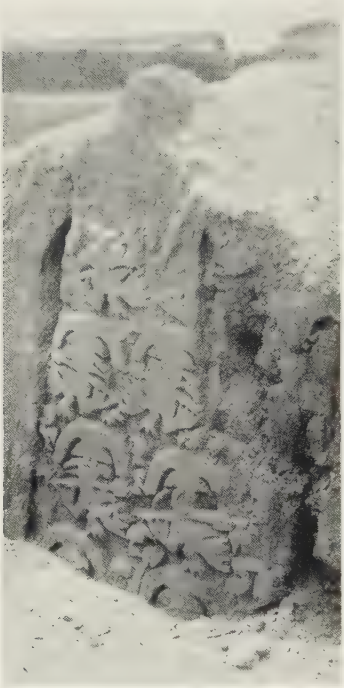

FIG. 21—Figures in high relief on wall.

THE RUINS AND THEIR APPEARANCE TODAY

With this brief outline of the history and cultural character of the coastal peoples we may turn to a more detailed description of the ruins themselves as they now appear. They are particularly interesting in their present aspect because of the effects of the destructive rains of March, 1925, mentioned above.[13] The accompanying photographs show quite clearly how great were the effects of the falling rain and the rainwash and what serious losses will be sustained if there is any further delay in the systematic and thorough study of these notable structures. At first view the ruins present the appearance of a labyrinth, a confused jumble of fallen walls and débris, but closer observation reveals streets, courts, walls, houses, reservoirs, and sunken gardens laid out with great skill and exactness. The ruins of great palaces with their halls, gardens, and spacious patios are still to be seen. The city itself, the gardens, fields, and patios were once well-watered by a great canal which now only appears as the bed of a dry creek or brook leading from the river Moche.

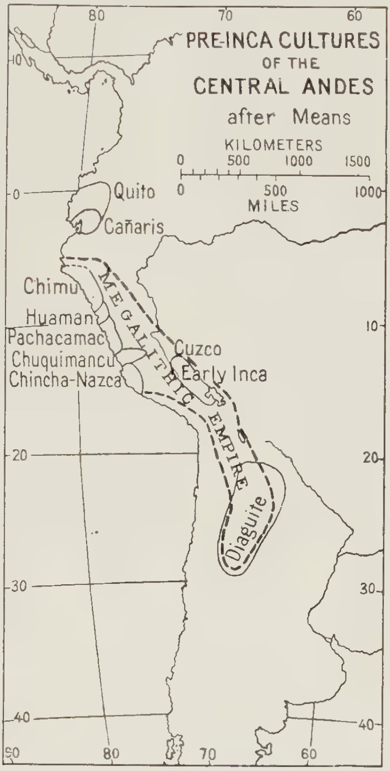

FIG. 22—Map showing the pre-Inca cultural regions of the Central Andes. After Map 1 in P. A. Means: An Outline of the Culture Sequence in the Andean Area, *Proc. 19th Internatl. Congr. of Americanists, Held at Washington, Dec. 27–31, 1915*, Washington, 1917.

The structures are of *cascajo* (coarse gravel) mixed with a cement-like mud into a material of great consistency and strength. The walls are quite high and of considerable thickness, some of them rising to 30 or 40 feet with a thickness of nine or ten feet at the base, and inclined slightly inward with their surfaces converging toward the top to give them greater stability. At the tops, abraded by the winds and eroded by the rains, which come at rare intervals, are to be seen the tips of reeds (Fig. 8), apparently used as guides to mark the courses of the walls during the process of building. From paintings on some of the pottery unearthed in the ruins we know that the roofs had considerable slope and that they terminated in a ridge of adobes or sun-dried bricks. Squier[14] comments as follows: "The roofs were not flat, but, as shown by the gables of the various buildings, sharply pitched . . . " The doorways, like the walls, converged toward the top. They were closed by reed mats or by skins, since carpentry was little developed. Trees are scarce along the coast, and timber from distant sources was not available. In construction work hewn wood was used, as shown by Squier, who reports the recovery of a beam of algarroba wood five feet long and nine inches by five inches in cross section supporting the roof of a passage. Despite the limited occurrence of the material the people were masters at wood carving, as is attested by remarkable examples taken from the ruins.

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[13] For a general account of the rains on the Peruvian coast see R. C. Murphy: Oceanic and Climatic Phenomena Along the West Coast of South America During 1925, *Geogr. Rev.*, Vol. 16, 1926, pp. 26–54. Data and photographs for Trujillo were furnished by the present writer.

[14] *Op. cit.*, p. 161.

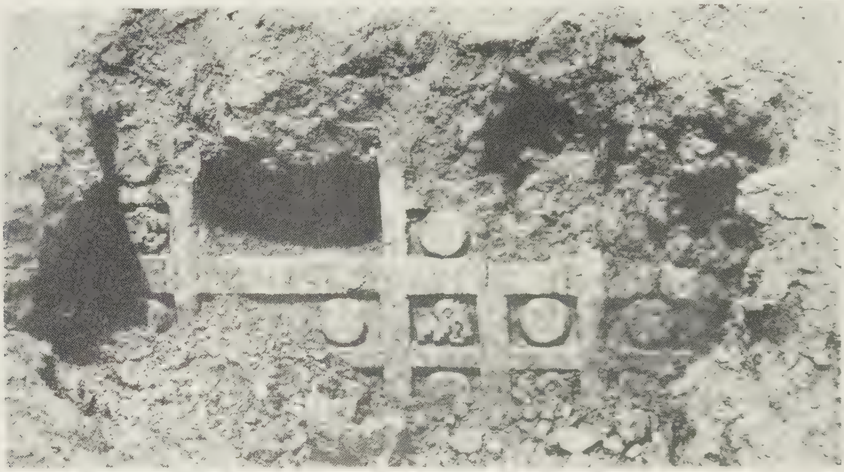

FIG. 23—Burial niches in wall.

Within the angle formed by the roof and in the center of the walls opened windows of circular form. From appearances the houses were but poorly ventilated, the principal function of the windows being to allow the escape of smoke. Some of the edifices—temples in all probability—were built on mounds especially raised for the purpose, calling to mind the ruins of Uxmal, Palenque, and other places in the north. Some notable *huacas*, or burial mounds, still exist, the largest of these being Esperanza (formerly known as Del Obispo) today badly defaced by the ruthlessness of treasure hunters. This *huaca* contains fifty million cubic feet of material. The most famous of all the *huacas*, however, is El Peje Chico (The Little Fish) or Toledo, from which considerable treasure in the form of gold and silver objects has been taken. Hutchinson[15] obtained from a reliable countryman a treasure record copied from the original accounts in the archives of the municipality of Trujillo. The entries were taken from the book of "Fifths of the Treasury" for the years 1577 and 1578 and refer to the Royal Fifth which was paid into the treasury as a tax, determined on the basis of the weight of the gold and silver objects. The figures relate exclusively to the Huaca of Toledo. In 1577, at two different dates, 11,318 gold pesos (Spanish dollars) were paid in. In 1578, on six different dates, additional sums totaling 266,856 gold pesos were paid. Rivero and von Tschudi[16] report that from the books of the royal coffers of Trujillo of 1566 Gutierrez of Toledo recorded the king's fifth as 85,547 dollars in gold (also from the Huaca of Toledo); and in 1592, 47,020 dollars. Middendorf[17] makes a critical comparison of the statistics available and concludes that the total of the king's fifth between 1566 and 1592 recovered from the Huaca de Toledo amounted to 941,054 gold dollars, which means that the value was perhaps little less than one-and-one-half million dollars at present standard of currency, not taking into account the difference in the value of money between then and now. Since this sum represented the king's fifth only, the total value of the treasure recovered from this one spot was between five and seven million dollars.

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[15] T. J. Hutchinson: Two Years in Peru, with Exploration of Its Antiquities, 2 vols., London, 1873; reference in Vol. 2, pp. 153–160.

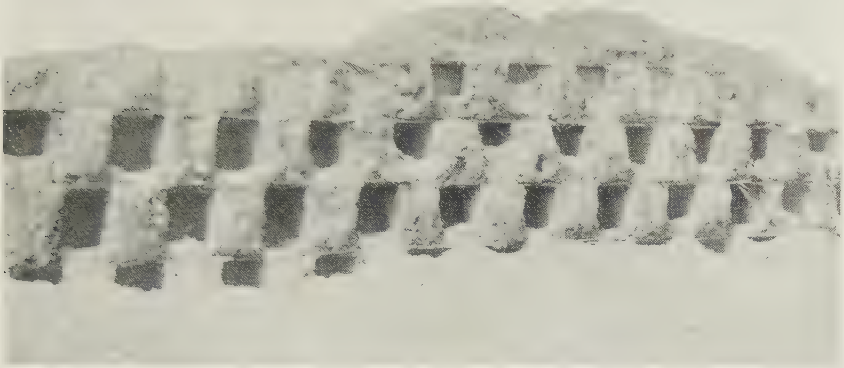

FIG. 24—Post office box-like receptacles in wall.

The palaces were rectangular in form, and some of them covered as much as 600,000 square feet. One in particular is unique in that it has nine rows of small cells, in groups of five, numbering 45 in all, each 14 feet long by 8 wide and 9 high. It has been thought that these were for prisoners, since the walls at this point have large stones imbedded in them. In other parts of the ruins, however, these small cells are found but without excessive strength of walls, so that they may well have been used to store treasure, clothing, utensils, arms,

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[16] *Op. cit.*, p. 268.

[17] E. W. Middendorf: Peru: Beobachtungen und Studien über das Land und seine Bewohner 3 vols., Berlin, 1894; reference in Vol. 2, p. 379.

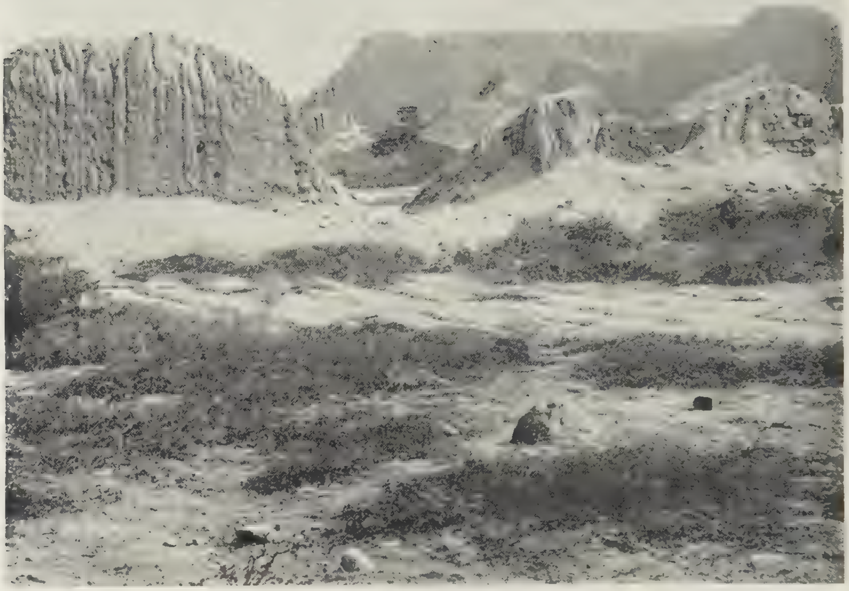

FIG. 25

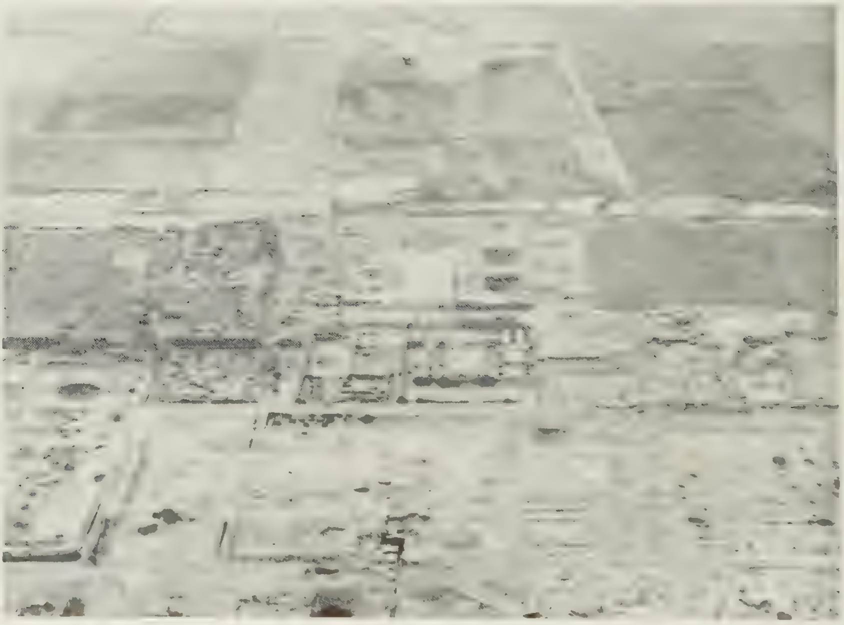

FIG. 26

FIG. 25—Walls of Chan-Chan. Note marks of plow furrows in foreground.
FIG. 26—A view of Chan-Chan looking east. The *huaca* Esperanza in the distance.

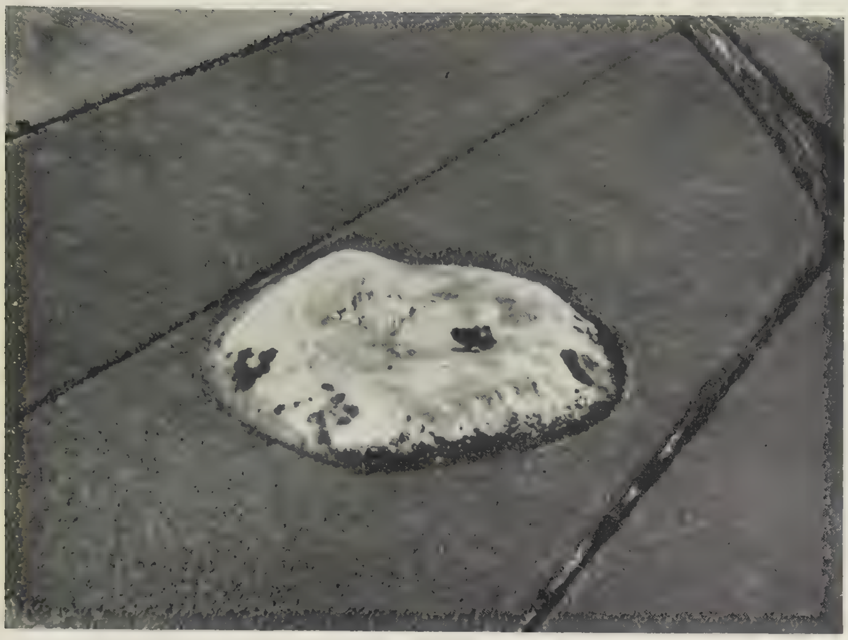

FIG. 27

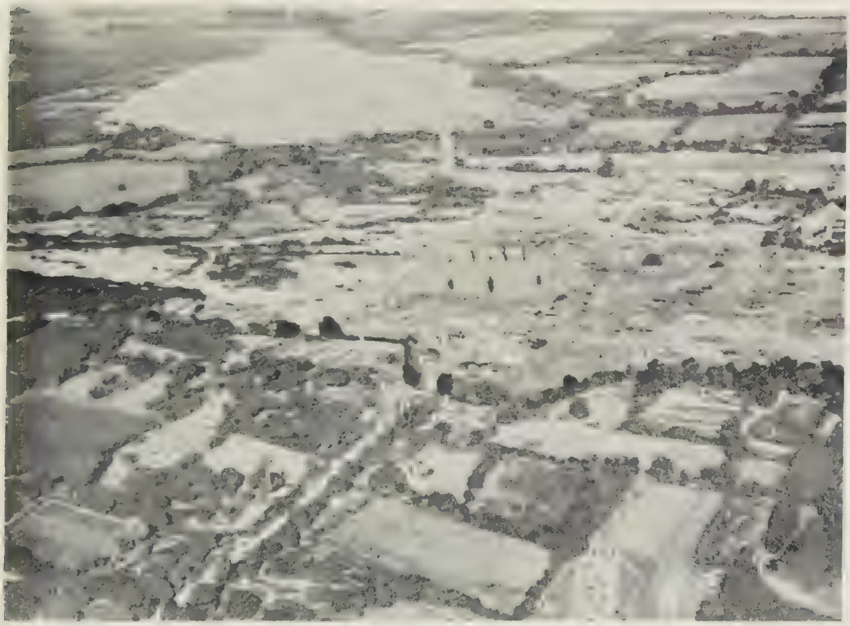

FIG. 28

FIG. 27—*Huaca* in the Chicama valley with ruins of a Catholic church built thereon.
FIG. 28—The town of Virú with *huaca* near by.

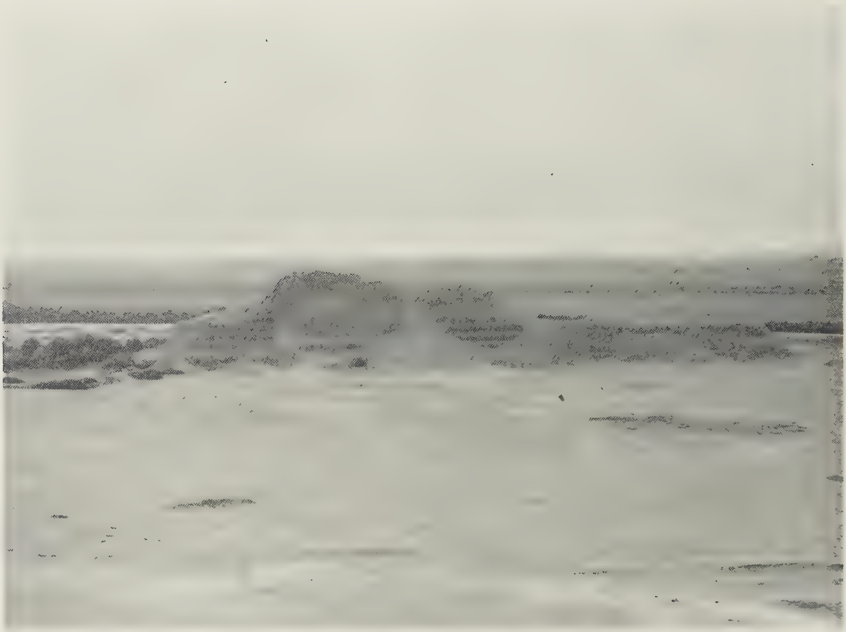

FIG. 29

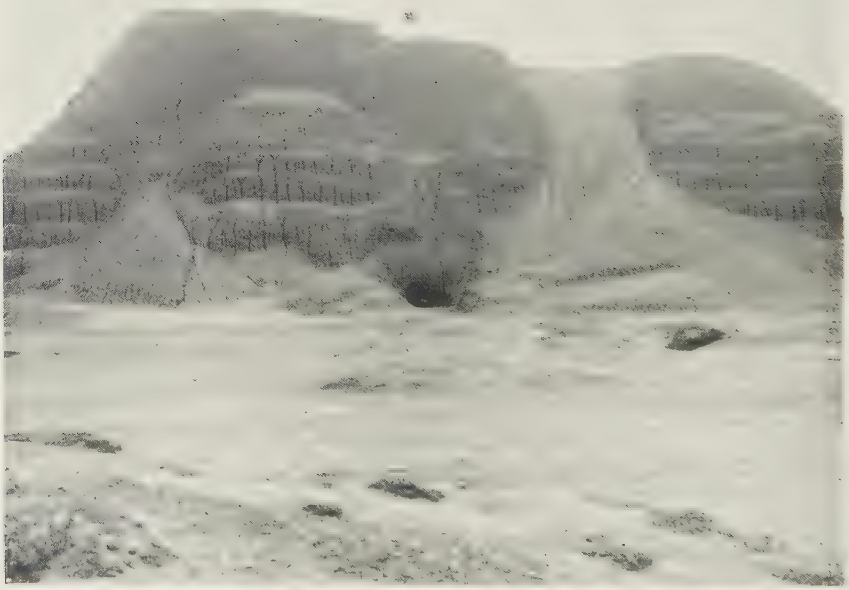

FIG. 30

FIG. 29—The Huaca of the Sun (see Fig. 1). Trujillo is to the right beyond the lowest part of the *huaca;* beyond the highest part, on the horizon, is Huanchaco; midway between the two points lies Chan-Chan.

FIG. 30—Near view of the Huaca of the Sun, showing the terrible damage caused by erosion and slides as a result of the rains of March, 1925.

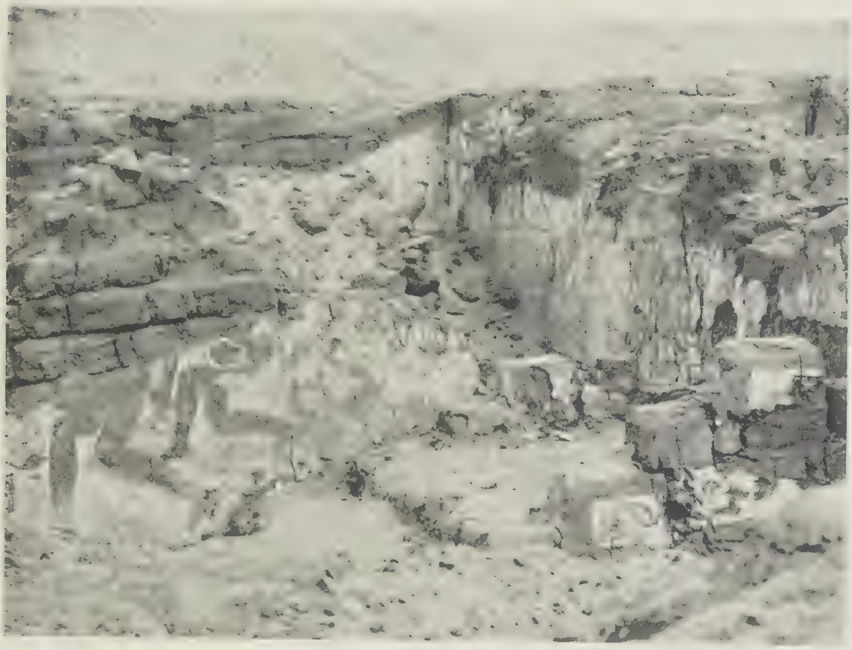

FIG. 31

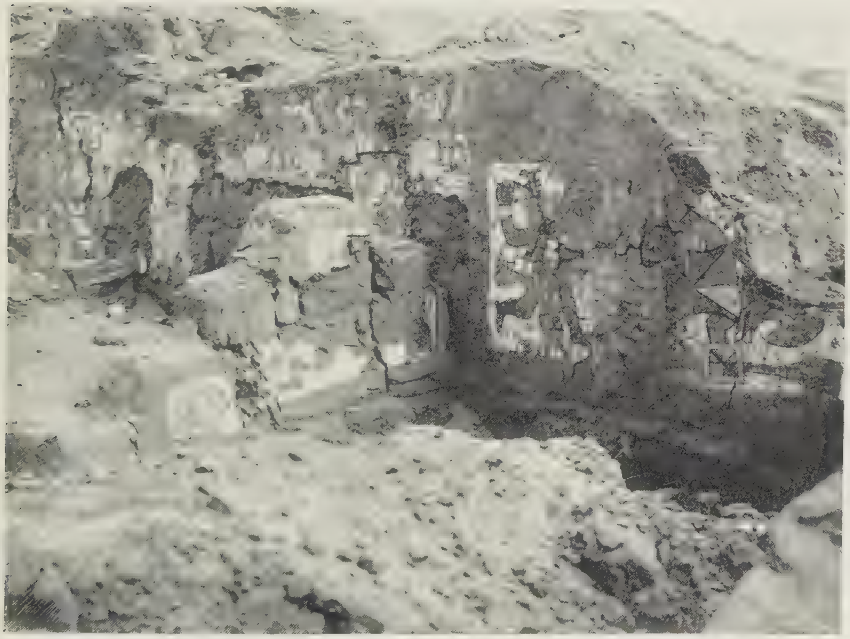

FIG. 32

FIGS. 31 and 32—Mural paintings, Huaca of the Moon. The colors used are black, reds, orange, yellows, and blues on a white ground. Some figures have been sketched in but not colored.

or the like. Another palace which, according to Feyjóo de Sosa[18] (a political officer in the time of the Viceroy de Superunda during the reign of Carlos III, 1745 to 1761), belonged to the chief, is peculiar in that it is built adjoining the *huaca* of Yomayocgoán. This *huaca* was the burial place of the sovereigns of the Chimu. It incloses various galleries and small rooms lined with honeycomb-like niches in the opposite walls on both sides of the entrance, and it was near these that the Spaniards found mummies dressed in richly woven woolen garments and adorned with gold and silver ornaments in the form of fishes and other animals. Among other objects found, we are told, were some that represented insects in which "the center of gravity was so well studied that when thrown into the air they imitated flight before falling to the earth." The walls of the principal room of this great palace measured 45 feet in length. Adjoining it was a sort of living room whose walls were wonderful examples of the mason's art. A number of doors gave access to other smaller rooms. This may have been the living room of the ruler, and the other smaller ones those of his wives and concubines.

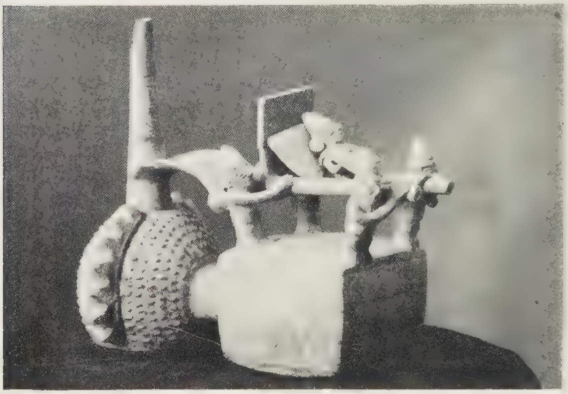

Fig. 33—A wonderful example of Chimu or pre-Chimu pottery of the earliest period. This particular piece represents a funeral scene.

The walls of both palaces and of many other buildings—possibly all of them—were profusely decorated in high relief, some worked in plaster in the form of animals, stars, leaves, circles, and complicated interlaced lines similar to some of the Chinese ideographs and executed with admirable regularity and precision. The friezes stood out from a painted background of bright colors which have entirely disappeared but which have been seen by some of the oldest inhabitants now living in Trujillo. The climate and relatively dry atmosphere aided greatly in the preservation of these decorations. Some particularly interesting mural paintings from the near-by Huaca of the Moon (see Fig. 1) are shown in Figures 31 and 32.

Tanks, baths, gardens, and avenues adorned the city. The tanks are still to be seen, and the fact that they were dug down to water is attested at this day by the existence of green plots upon the tank

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[18] Miguel Feijóo de Sosa: Relacion descriptiva de la ciudad, y provincia de Truxillo del Peru, con noticias exactas de su estado político, Madrid, 1763.

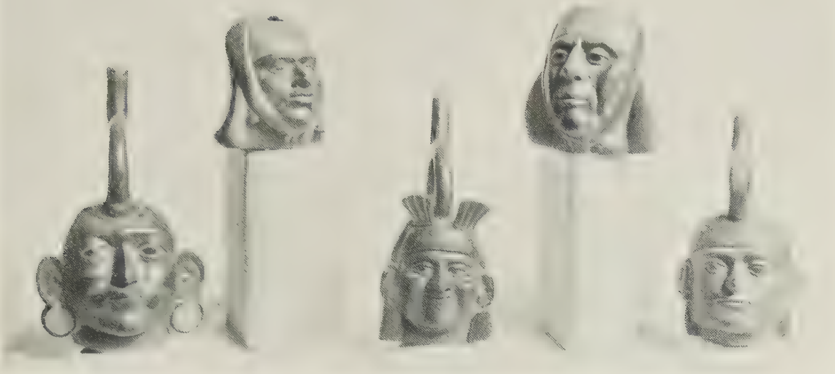

FIG. 34—Examples of the art of the Chimu potters, showing their extraordinary skill in depicting facial expression.

floors—practically the only plant life still to be found in the ruins. One measures 600 yards in length by 50 in width, and another approximately 500 feet in length by 195 in width and 60 in depth.[19]

Outside of the Chan-Chan area and east by north of Trujillo was one of the principal reservoirs.[20] Wiener presents a plan in detail of the aqueducts about the site of Chan-Chan, but one gathers from his description and plan that only the principal aqueducts can be seen today and the smaller distributaries are to be inferred. In any case, the large reservoir now called "La Manpuesteria" was fed by

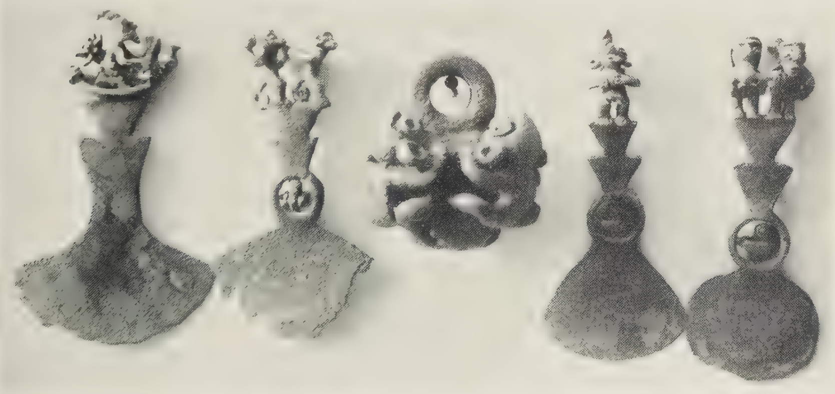

FIG. 35—Examples of Chimu copper work. From left to right: man rowing a *balsa;* two monkeys, one carrying a basket on his back, the other in act of throwing a ball; ball with four monkey-like animals climbing up sides, probably tied to a thong and used as a weapon; man adjusting pack on his back; man carrying olla and blowing conch, and hunter carrying a deer. (From the Holstein collection at the American Museum of Natural History, New York.)

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[19] Squier, *op. cit.*, p. 155, gives the dimensions of one as 450 feet long by 195 feet wide by 60 feet deep and says that there are a hundred others of larger or smaller size.

[20] It is shown upon Hrdlička's map, Anthropological Work in Peru, p. 47, and in Wiener, *op. cit.*, p. 98; but the latter has a wrong orientation upon his map, east being given as north.

the river Moche. By means of this and other reservoirs the plain about Chan-Chan was irrigated and the city reservoirs kept filled for the needs of a great population even when the river Moche was at low-water stages or when the season was particularly dry. Clearly such elaborate works can only mean a population so large as to put to the test their utmost skill in finding the necessary water supply.

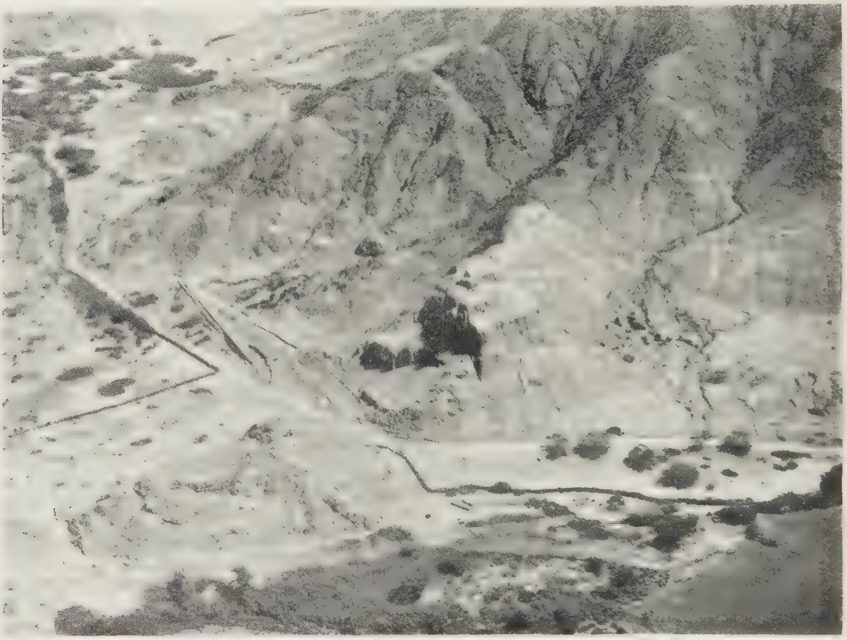

FIG. 36—Ruins of fort in the Virú valley.

That these people were skillful artisans in gold, silver, copper, wood, and clay is attested by the fact already mentioned that wonderful specimens have been taken from the ruins in past years and are still occasionally found. No one can examine the accompanying photographs or the published illustrations of Chimu art[21] without experiencing great surprise first at the quite remarkable realistic quality of the pottery, the wide range of representation calling for an equally wide range of technical skill and artistic expression. They showed great skill in depicting facial expressions, and every human emotion from agony to mirth is registered in this form. In a relatively short time a people of unusual capacity and intelligence was able to take care of the material side of life, construct great engineering works, build massive and time-defying monuments, and with it all develop an effective and powerful political and social organization that reached its cultural climax in a very high level of specialized forms of art.

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[21] As given, for instance, in Middendorf, *op. cit.*, Vol. 2, pp. 390, 391, 393, in Kroeber's reproduction of figures from the Uhle collection, or in the superbly illustrated volume by Walter Lehmann and Heinrich Doering: Kunstgeschichte des alten Peru, Berlin, 1924.

The ruins of Chan-Chan are today in a very poor state of preservation, in part by the ruthlessness of treasure hunters who have plied their tools without regard for the scientific interests the ruins hold. Seismic disturbances and meteorological phenomena, which have occurred at intervals, have also done their share of destruction. An earthquake on February 14, 1619, razed every house in Trujillo within the space of one minute; another on January 6, 1725, was but slightly less severe; in 1739 a third one occurred. Paz Soldan states that the great earthquake of 1687 made vast tracts sterile.[22] Feijóo de Sosa reports similar soil effects at Lima. Owing to the apparent flexibility of the material and the construction of the walls, Chan-Chan seems to have suffered less from earthquakes than from the rains which appear to occur in cycles at considerable intervals. The rains of 1701, 1720, and 1891 must have done great damage to the ruins,[23] judging by effects observable from the rains of March, 1925.

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[22] Mateo Paz Soldan: Geografía del Perú, Vol. 1, Paris, 1862, p. 212.

[23] Feijóo de Sosa mentions the rains of 1720, 1728, and 1747 as especially noteworthy.

THE CAMINO DEL DIABLO: WITH NOTES ON A JOURNEY IN 1925

Godfrey Sykes

Desert Laboratory, Tucson, Arizona

THE road from Ajo to Yuma by the Camino del Diablo ("devil's road") is probably the most difficult and dangerous route in the Papago country. The region west of the Growler Mountains, east of the bluffs of Colorado River, and south of the Southern Pacific Railroad, an area 60 miles wide on the east and 20 miles wide on the west and nearly 100 miles long, has only one permanent inhabitant, who is the caretaker at the Fortuna mine.[1]

The Camino del Diablo follows quite closely the United States-Mexican border (see Fig. 1). The above quotation describes the northern part of the region through which it runs: the southern, or Mexican, part is drier and if possible less inhabited over a vast extent.

EARLY TRAVELERS

The first recorded journey over this famous road was made early in the year 1699 by Father Eusabius Kino, the pioneer missionary amongst the various Indian tribes of Pimeria Alta and Papagueria—today southern Arizona and northern Sonora. Accompanied by Commander Juan Matheo Mange, Father Adamo Gilig, and a numerous retinue of servants, Indian guides, and camp followers, together with some ninety head of pack and riding animals, Father Kino left the outlying Spanish settlements on the Magdalena River on an expedition to the distant Indian tribes along the lower Gila.

It is difficult to identify the exact course taken, even with a thorough knowledge of the region and the help afforded by the map and diary of Kino and the journal of Mange, but there is little doubt that it approximated pretty closely to the route followed by Kino upon several subsequent occasions, which in part developed into and gained unenviable notoriety a hundred and fifty years later as the dreaded Camino del Diablo.

The Kino-Mange party made their journey in midwinter, and, as they had been delayed by heavy rains before leaving the Spanish settlements, the season was undoubtedly a favorable one for crossing the desert. They traveled, under Indian guidance, first towards the north to Tubutama and Saric, then almost due west until they dropped into the drainage of the Rio Papago, or Sonoita River. The little Indian settlement of Sonoita, which has survived as the small Mexican hamlet of the same name, was then, as it remains today, the last focus of human activity towards the northwest. Indian guides for the desert were secured at this place, water was obtained at the associated watering place of Carrizal, and the fifty-three leagues which remained between there and the Gila were safely traversed in five days.

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[1] Kirk Bryan: The Papago Country, Arizona: A Geographic, Geologic, and Hydrologic Reconnaissance with a Guide to Desert Watering Places, *U. S. Geol. Survey Water-Supply Paper 499*, Washington, 1925, p. 413.

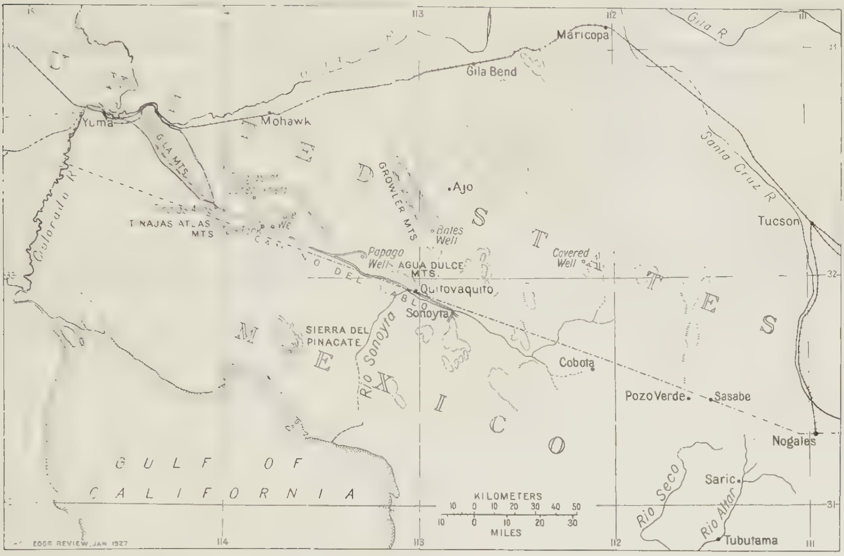

FIG. 1—Sketch map of southwestern Arizona and northwestern Sonora showing the location of the Camino del Diablo. Scale 1:3,600,000.

The route forms a chord to the great arc made by the upper Altar, Santa Cruz, and Gila valleys; which was otherwise the logical route to have followed, inasmuch as water and forage for their animals would have been pretty well assured. The saving in distance was a very substantial one, however, the total mileage being some two hundred and thirty as against nearly four hundred for the longer but safer way.

There is no record available of any further use of the desert route by white travelers for many years after Kino's time; but, as Spain began to develop possessions and interests in California Alta in the last quarter of the eighteenth century, it again became a recognized line of communication between the Sonoran settlements and the western coast and began to take its heavy toll of human and animal life.

Father Garces traveled from the Magdalena settlements to the mouth of the Gila in 1772 by way of the desert and acted as unofficial guide for the expedition of Commander Juan Bautista de Anza over the same route in January, 1774. By this time the name, Camino del Diablo, seems to have been established and applied to the particularly hazardous hundred and fifty miles which must be traversed between Sonoita and the Gila.

Between these two points water can be found, and then in very limited quantity, at only two places, with the added possibility after heavy rainfall of a further scanty but evanescent supply at one other spot. The two more-or-less assured natural supplies are in *tinajas*, natural eroded basins in the rocky mountain sides, which serve as concentration points and catchment basins for rain water. The occasional supply is in a series of *charcos*, shallow pools, where the soil is sufficiently impervious to retain water until it is dried up by evaporation. Forage of any description is scant except for brief periods after the infrequent rains and even then is poor and unsustaining in quality.

Even to the seasoned and reasonably well-equipped desert traveler such a journey involves some serious risk, especially during the hotter months of the year, through the possible breakdown of equipment, loss or exhaustion of stock, or failure to find a supply of water at known watering places; while for those whose equipment or strength does not reach a certain rather definite standard, disaster is almost certain.

Later Use of the Road

It was during the period of the first great overland rush to California, beginning in 1849 and lasting through the early fifties, that travel along the Camino del Diablo reached its maximum and the loss of life became most appalling. Parties were hurriedly and inadequately organized and equipped at various points along the Texas frontier and did not realize the danger they were involved in until the small Sonoran settlements were left behind and the desert was actually surrounding them.

Various estimates have been made as to the deaths from thirst and other mischance between Sonoita and the Colorado during these few years of wild excitement; some placing the numbers at hundreds, others at thousands. The facts can never be known, but it is significant that over fifty rude graves can be counted still in one small area at the foot of the rocky chine which contains the Tinajas Altas. Numerous others can be identified along the route, in spite of the obliteration due to time, wind, and occasional torrential rains, and of the probability that the actual line of travel was several miles in width except at certain focal points such as the tinajas.

Placer gold was discovered at various places in the Colorado valley just before 1860, and another wave of excited gold seekers began to pass over the desert to reach the new camps. These travelers were mostly Mexicans from Sonora and other near-by Mexican

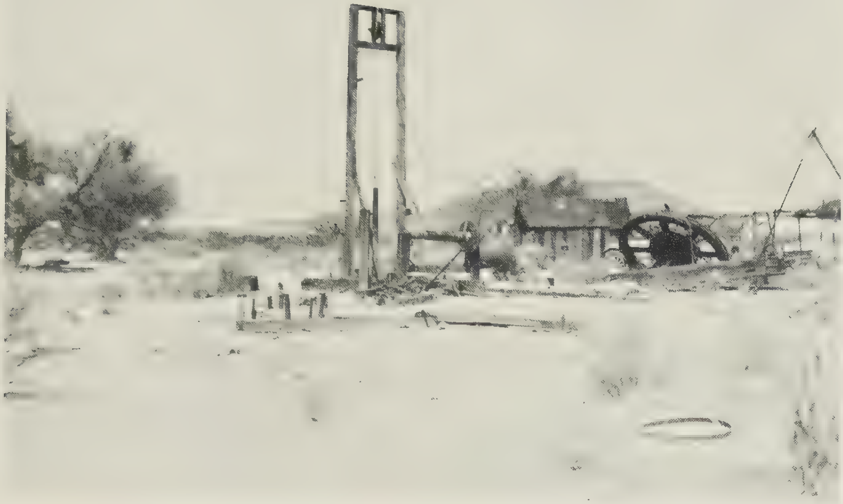

FIG. 2

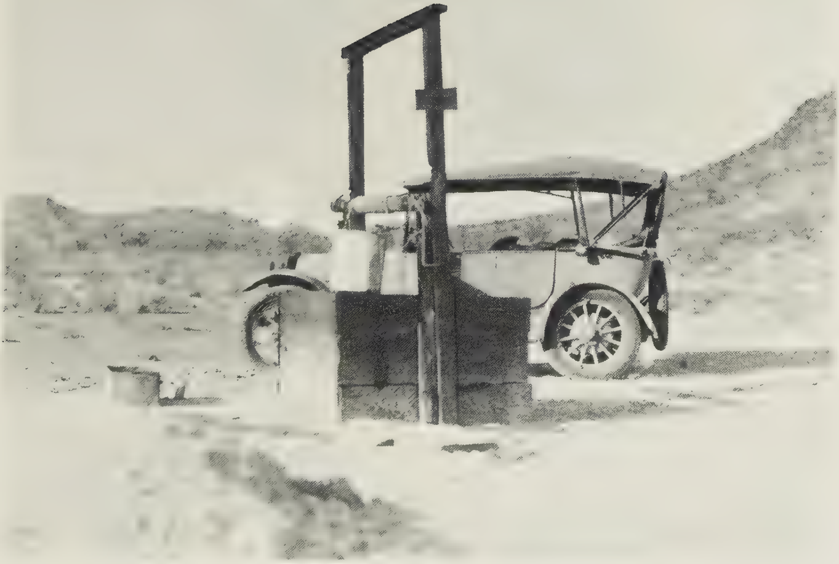

FIG. 3

FIG. 2—Papago Well. The deep borehole is under the headframe, the sand pump can be seen suspended above the well casing.

FIG. 3—Tule Well. The desert guidepost in the background.

states. The loss of life was again very heavy, and in a few years the road was almost abandoned, even by these native Sonorans, as being too dangerous. The alternative route along the Gila was commonly used before the mid-sixties.

The region has remained entirely undeveloped and practically unknown from that day to this, save for an occasional mining prospect in some of the surrounding mountain ranges. The old road itself is but seldom traveled, although two wells in which water can always be obtained now exist, one at either end of the most dreaded stretch.

The International Boundary Commission, which surveyed and remarked the boundary line between the years 1891 and 1896, examined the border strip, which includes a large portion of the old Camino, quite thoroughly in the course of their work, and the description of it given in the official report merits quotation:

> During the "early sixties" there was a large influx of Mexicans from Sonora to the gold diggings on the Colorado River, and an enterprising Mexican dug two wells near the road, in the Tule Mountains, built a small adobe house, and occupied it with his family for two years, for the purpose of selling water to travelers. But the deaths from thirst along this route became so frequent that the road was soon abandoned, and for over twenty years had remained unused. Having accidentally learned of the former existence of these old wells, which are not shown on any maps, arrangements were made to have them cleaned out as soon as possible. This was done by a party of Mexicans and Papagos from Sonoyta, who found them almost filled up.
>
> These important wells are situated on the road about 5 miles north of the point where the line crosses the summit of the Sierra del Tule, and when thoroughly cleaned out yield a supply of about 500 gallons per day. The water is beautifully clear, but owing to the presence of minerals has a vile taste and is very unwholesome. Near the wells stand the ruins of the old adobe house, the only building between Quitobaquita and the Colorado River.[2]

At the present time only one of these two wells is in repair. It is maintained as a desert watering place by Yuma County and has one of the excellent signposts established by the United States Geological Survey placed close to it. The report continues:

> The road between Agua Dulce and Yuma is for the most part very heavy, and, until the Tule Wells were reopened, no certain supply of water could be counted on between Agua Dulce and the Colorado River. This road is appropriately called by the Mexicans "El camino del Diablo." When traveling it for the first time, alone or with but few companions, it is hard to imagine a more desolate or depressing ride. Mile after mile the journey stretches through this land of "silence, solitude, and sunshine," with little to distract the eye from the awful surrounding dreariness and desolation except the bleaching skeletons of horses and the painfully frequent crosses which mark the graves of those who perished of thirst—grim and suggestive reminders when the traveler's supply of water is running low. In a single day's ride sixty-five of these graves were counted by the roadside, one containing an entire family, whose horses gave out and who, unable to cross the scorching desert on foot, all perished

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[2] Report of the Boundary Commission upon the Survey and Re-marking of the Boundary Between the United States and Mexico West of the Rio Grande, 1891 to 1896, Washington, 1898, Part II, pp. 24–25.

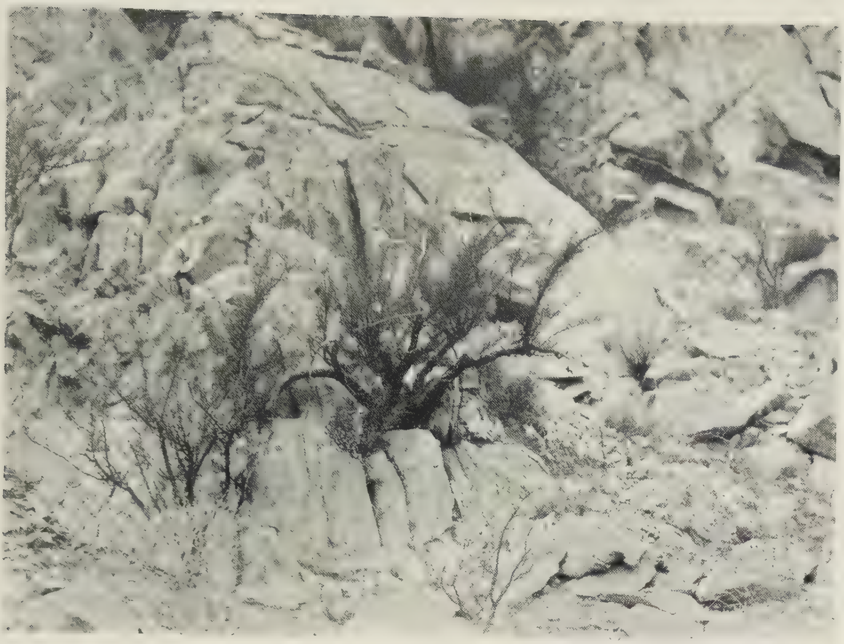

Fig. 4

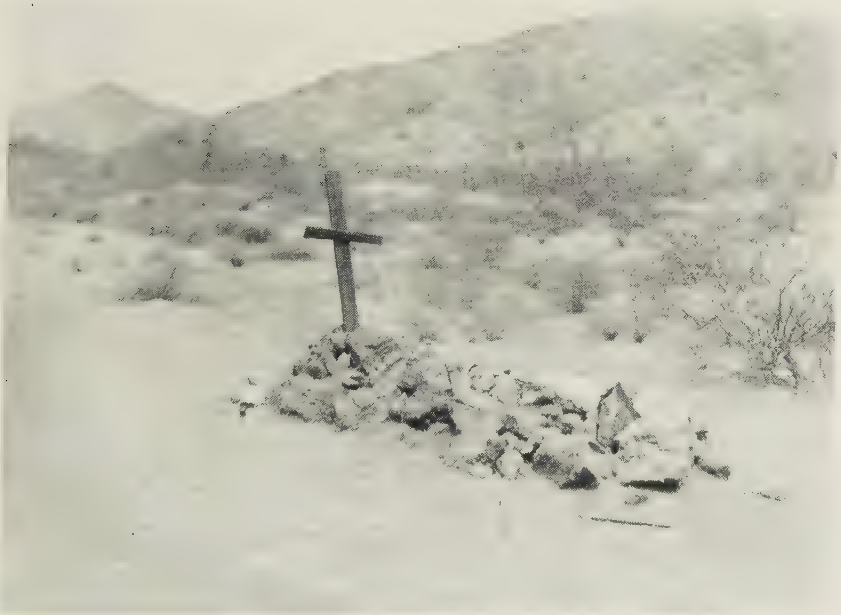

Fig. 5

Fig. 4—Vegetation amongst rocks at Tule Tanks (principally *Elaphrium microphyllum*).
Fig. 5—A roadside grave on the Camino del Diablo.

> together of thirst. Their bodies were found by some travelers during the following rainy season, and were all buried in one grave, which is covered with a cross of stones and surrounded with a large circle of stones, inside of which not a bush nor a blade of grass grows. Near by lie the skeletons of their horses and the broken fragments of their water bottles.
>
> During the few years that this road was much traveled, over 400 persons were said to have perished of thirst between Sonoyta and Yuma, a record probably without a parallel in North America.[3]

The other well now existing on the old Camino is a deep bore known as the Papago Well, and this is also marked by a desert signboard. Obtaining water from it is a rather laborious process, the only means of raising it being a sand "pump," which is lowered into the bore by a winch and steel cable.

Since the development of motor transportation a few travelers use the route each year. As it follows the border closely, border line-riders are at least supposed to pass along it occasionally, although it would be well for intending desert wayfarers not to rely too much upon their presence and assistance at any given time.

For the driver of a car, the question of water has ceased to be the most serious one in desert traveling. Sand, rough surface, and cross-washes are likely to prove much more formidable; and of course the danger of breakdown when far from possible help is always to be reckoned with. It is these matters that make a journey undertaken and successfully accomplished by the late Raphael Pumpelly and some members of his family over the Camino, in the spring of 1915, the more notable. In striking contrast were the conditions of his earlier journey along the road in 1861. That journey also was successful although made in July; but his party was fortunate enough to encounter a heavy rain while crossing the Tule Desert.

Lumholtz traversed portions of the route in 1910, when engaged upon his examination of northwestern Sonora, and visited and camped at both Tule Tanks and the Tinajas Altas. He was, of course, fully prepared to encounter any ordinary desert conditions and traveled with Indian and Mexican assistants who knew something of the country. His work in this region was accomplished in winter and early spring, when the heat is not a serious factor.

An Example of Desert Thirst

During the summer of 1905 the late Professor McGee camped in quite primitive fashion at the Tinajas Altas for more than three months, gathering meteorological and other data. He records a remarkable case of what he describes as "desert thirst." A Mexican prospector, 40 years old, well versed in the ways of the desert and exceptionally strong and robust, was out on the desert to the south

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[3] *Ibid.*, Part II, p. 26.

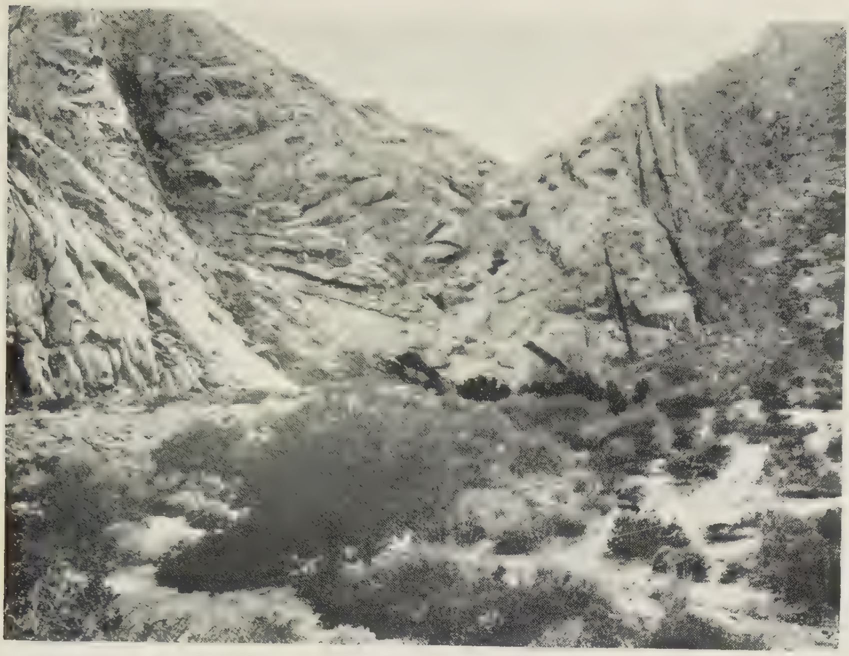

FIG. 6

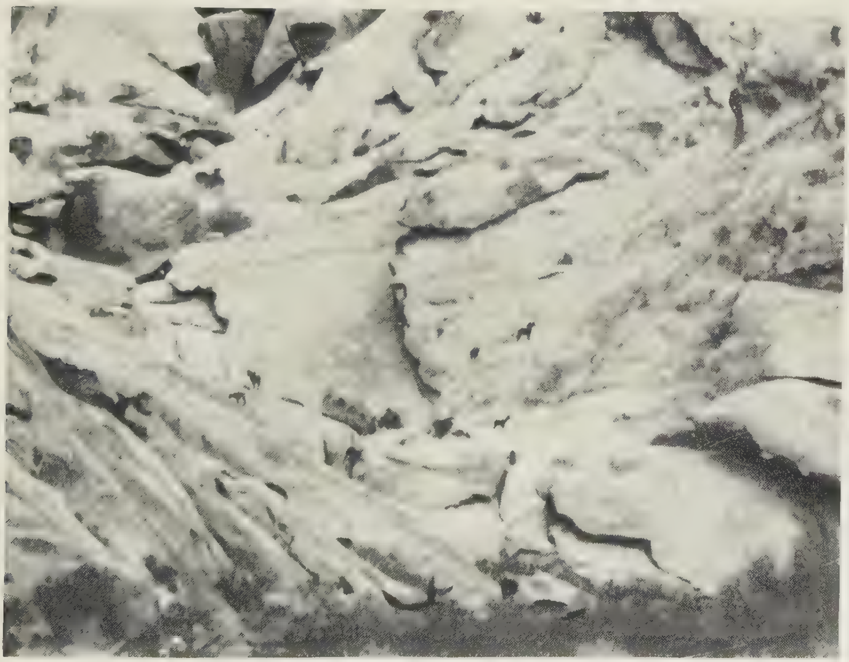

FIG. 7

FIG. 6—A general view of the Tinajas Altas (see also Figure 8).

FIG. 7—Telephotographic view of the Tinajas Altas from a distance of half a mile. A number of mountain sheep (*Ovis Nelsoni*) can be seen on the rocks.

of the Camino for a period of nearly eight days with a supply of water not more than sufficient for two days, and yet he succeeded at length in crawling back to McGee's camp at the Tinajas. Dr. McGee and his Indian helper, aroused by a hoarse, rasping, bellow, quite unlike a human voice, ran down the trail: "and on the arroyo sands, under an ironwood tree, at the foot of the Mesita de los Muertos with its two-score cross-marked graves, came on the wreck of Pablo."

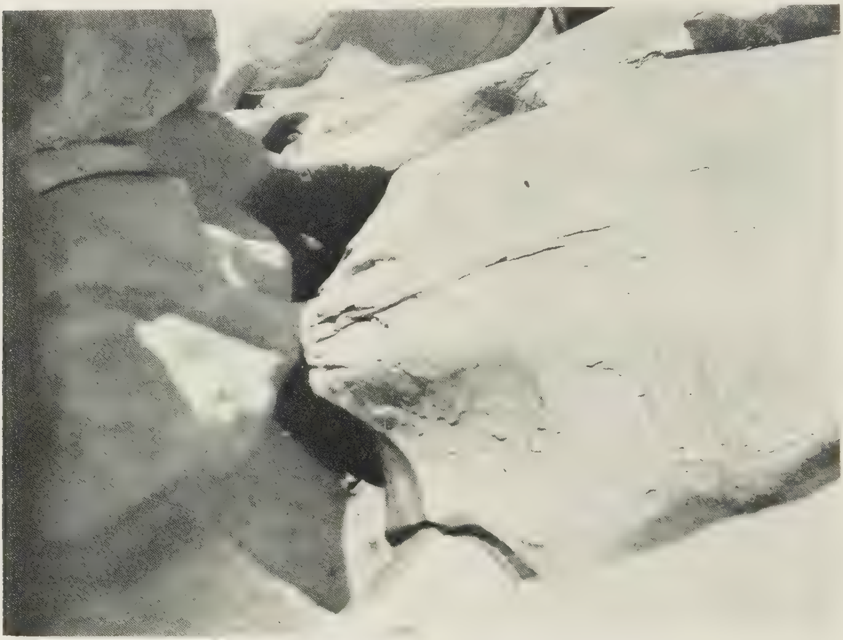

Fig. 8—The Tinajas Altas (see Figure 6). Looking down the chain of *tinajas*. This view was taken from the top of the chine, with the camera pointed downward at an angle of about 35°.

> He was stark naked: his formerly full-muscled legs and arms were shrunken and scrawny; his ribs ridged out like those of a starveling horse; . . . his lips had disappeared as if amputated, leaving low edges of blackened tissue; . . . his eyes were set in a winkless stare, with surrounding skin so contracted as to expose the conjunctiva; . . . his face was dark as a negro, and his skin generally turned a ghastly purplish yet ashen gray . . . his lower legs and feet, with forearms and hands, were torn and scratched by contact with thorns and sharp rocks . . . yet without trace of blood or serum.[4]

In spite of his serious condition Dr. McGee succeeded, after several days, in restoring him to a condition in which he began gradually to regain his strength and weight; although the ordeal through which he had passed had thinned and whitened his hair, and he remained dazed and uncertain in speech and memory for some little time afterwards.

Dr. McGee states, with emphasis, that the mental habit of the man was all important, and I fully agree with him upon this point. My own experience in nearly forty years of desert work and travel has taught me the same thing. Two men of nearly equal physique and strength may be lost or forced to endure prolonged exposure in the desert under almost identical conditions. The nervous and excited man will die, while the phlegmatic or "nerveless" one will survive. The ability to endure and accomplish heavy physical labor under prolonged high temperature seems to be largely a racial matter. The Mexican, especially if his veins contain some Indian blood, can commonly withstand heat, if accompanied by low humidity, that causes distress to the average negro and almost total inability to undergo sustained exertion to the average Anglo-Saxon. In the particular instance described by Dr. McGee, furthermore, the weather was unusually favorable, the sky being overcast and the temperature comparatively low for the whole period.

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[4] W J McGee: Desert Thirst As Disease, *Interstate Medical Journ.*, Vol. 13, 1906, pp. 279–300; reference on p. 283.

The Author's Experiences

Circumstances occasionally arise, in a region such as the one under discussion, which show what the combination of high temperature and heavy physical exertion—even though unaccompanied by any great shortage of water—may mean even to those who are fully inured to the desert.

The early months of 1925 were extremely dry in southwestern Arizona, and July temperatures were rather above normal. The winter of 1924–1925 had passed almost entirely without rainfall, and in fact the whole of 1924 had also been exceptionally dry. In these circumstances an examination of the vegetation and desert water holes appeared to be advisable before the beginning of the expected summer rains. I started alone from Tucson in a heavy touring car on July 22 to visit several of the desert tanks, Tule Tanks and the Tinajas Altas amongst the number, and to make a general examination of the desert along the line of the old Camino. Ajo was passed the same afternoon, and I then struck south for the Mexican border. The temperature in and about Ajo was quite reasonable for the season, being but little over 100° F.; but the following day, on getting into the Tule Desert, I found temperatures averaging 115° in the shade of the car.

The road is but seldom traveled nowadays, although an excellent log of the portion of it lying on the United States side of the border is to be found in Water Supply Paper 449.[5] Upon approaching the northern end of the Pinacate lava field, which is flanked along each edge with belts of sand described by the compilers of the log as the most difficult parts of the road, I found that recent heavy winds from the south had not only obliterated almost all traces of the road but had produced a series of drifts and windrows of sand. Several hours of heavy labor at shoveling, cutting and laying brush in the track, and deflating and re-pumping tires were necessary before these troublesome stretches could be crossed. On this occasion the car was not equipped with any special devices for crossing sand.

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[5] See footnote 1.

This seemed a favorable opportunity for observing the combined effect on the human organism of heat, violent physical exertion, and the sparing use of water.

I think that it may be reasonably assumed that the question of environment and remoteness from any possibility of assistance did not seriously affect the situation, for it has been my habit for many years to make journeys of this description alone and often under similar conditions. I began the work about midday, with the temperature hovering around 115° at the start and gradually falling to 110° when I at last got clear of the sand at 4.15 p. m. The temperature of the water in my canteens remained at about 95°, and the water was used principally to rinse my mouth with; this is the habit of most Mexicans when at work in the hot sunshine. They drink only when resting or eating.

My pulse ranged from 78, which is about normal for a man of 64 at that temperature, to over 145, after a particularly strenuous half hour. It was not possible to take any reliable body temperatures, owing to the difficulty of working the mercury column down in the thermometer and also on account of the heated air which I was breathing. Twice during the early afternoon I approached the danger point that is almost universally recognized amongst desert workers—the sudden checking of perspiration. If this condition is not quickly remedied it is followed by collapse; but I was able in both instances to avert the danger by stretching myself out for a few minutes in the shade of the car.

I encountered more heavy sand later in the evening and also on the following morning, when working across country to visit and examine tanks in some of the surrounding mountains. This involved a good deal of deflating and re-pumping of tires although not much digging. Upon reaching the Tinajas Altas I climbed to the top of the mountain to inspect the higher tanks and again found a shade temperature of 108° at noon, with every indication of an increase. The Tinajas were almost dry—only two of the nine holes containing any water at all and these only some few gallons.

The net physical result of this journey was a temporary loss of fourteen pounds in weight, from 168 to 154, and some slight digestive trouble due, as I think, to eating some very doubtful canned food.

I again essayed the journey alone over the old road later in the summer, after some particularly heavy and torrential storms. Upon this occasion, however, my car was equipped with "sand treads" for

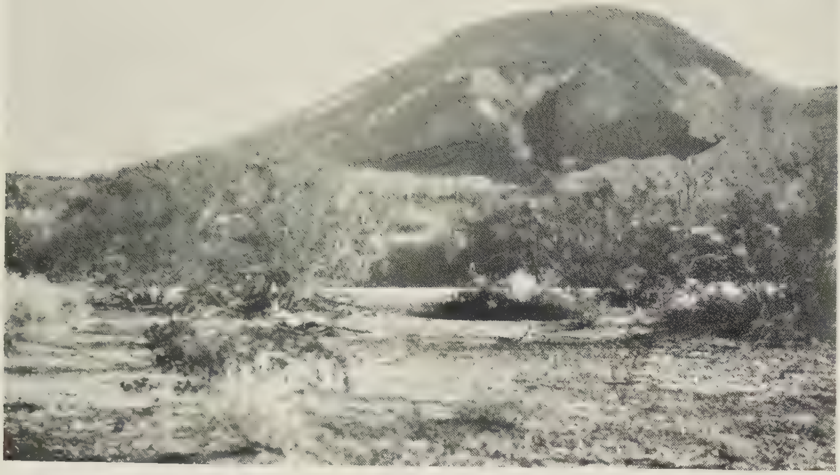

FIG. 9

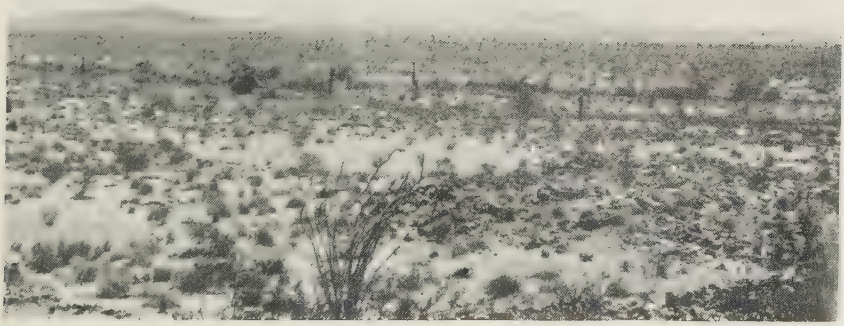

FIG. 10

FIGS. 9 and 10—Country through which the Camino del Diablo passes. Figure 9 is a view of Cabreza Prieta, north of the road. Figure 10 is the Pinacate lava plain to the south.

the wheels, which made deflation unnecessary. Roads were badly washed throughout the region, and some little digging was needed here and there in order to cross gullies and small washes. No other vehicle had passed along the road in either direction since my earlier trip; but, although the sand was soft in some places, the late rains had made it much more passable. The trouble now was to distinguish the road. The temperature was down into the nineties and hence quite tolerable.

Road conditions became steadily worse as I approached Tule Tanks, and I was obliged to shovel out several passages through deep arroyos. At last a point was reached from which the Tinajas Altas could be plainly seen across the intervening desert, but all traces of road had disappeared; and a reconnaissance on foot, extending over a radius of about three miles, at length convinced me that fully two days of single-handed digging and rock moving would be necessary before I could get clear of this plexus of trouble. I therefore reluctantly made my way back to Papago Well and then turned northward across some exceedingly sandy country to the little settlement of Mohawk on the Southern Pacific Railroad.

As a postscript I may add that a party of prospectors or other interested wayfarers succeeded in opening up the road a few months after this journey, and a little later my son also drove a car through with one companion. I have myself followed the greater portion of the old road twice in the last summer during my periodical inspection of the seasonal rain gauges that I have in commission in the region.

THE NEW PALESTINE

Andrée Choveaux

A PEOPLE is in movement. The Jewish people, wanderers for centuries and scattered all over the earth, are gathering anew on the land of Israel. It would seem that the longing, never lost, for the country of their ancestors is about to be satisfied. It is the culmination of several tentative efforts in recent years to resurrect the ancient kingdom of David. Especially is the development of Zionism associated with the Austrian Jew, Theodore Herzl, who headed the movement thirty years ago. But the realization of the Zionist dream involved so many social, financial, and political problems that its visionary nature was only too apparent. It was scarcely conceivable that Abdul Hamid, Commander of the Faithful, would relinquish Jerusalem with its mosque of Omar, next to Mecca and Medina the most sacred place of the Moslem world; or that the Christian nations would comtemplate with favorable eye a Jewish guard around the Holy Sepulcher. How would the Russian government accept a Jewish triumph in Palestine, reinforcing the power and pride of the Jews that remained on their territory? And how could the Jews of France, Germany, England, and America, sincerely attached to the countries of their adoption, be committed to the reclaiming of a new country?[1]

JEWISH IMMIGRATION INTO PALESTINE

How then has the unforeseen revolution in world affairs created by the World War thus miraculously transformed the dream into a reality? As the report of the High Commissioner for Palestine[2] puts it, "the fact that has dominated the situation" has been the Balfour Declaration made by the Foreign Office on November 2, 1917, and endorsed by several of the allied governments.

> His Majesty's Government view with favour the establishment in Palestine of a National Home for the Jewish people, and will use their best endeavours to facilitate the achievement of this object, it being clearly understood that nothing shall be done which may prejudice the civil and religious rights of existing non-Jewish communities in Palestine or the rights and political status enjoyed by Jews in any other country.

The Declaration, reaffirmed at the San Remo Conference in 1920, was subsequently embodied in the mandate for Palestine approved by the Council of the League of Nations in 1922[3] and endorsed by the United States.[4]

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[1] Jérome and Jean Tharaud: L'an prochain à Jérusalem!, Paris, 1924, p. 103.

[2] Palestine: Report of the High Commissioner on the Administration of Palestine, 1920–1925. Colonial No. 15, London, 1925.

The Jews had gained a country, and from Germany, Rumania, Poland, and Russia they issued forth in their thousands to the "reconquest" of their promised land.

From the British occupation (1917) up to March 31, 1926, Jewish immigrants to the estimated number of 83,000 entered Palestine. For the year 1923 the number was 7421; for 1924, 12,856; for 1925, 33,801.[5] The total number of Jewish settlements at the end of 1925 was 100, and the area of Jewish holdings of land in Palestine 1,100,000 dunam, or about 250,000 acres. These figures in themselves explain all "Erez Israel"—the official Hebrew expression for the commencement of the reconstruction of Israel. Along the roads and railways blossom unexpected patches of scattered settlement. Here are new houses of European aspect, with red roofs and blue window shutters, entirely unlike the native huts, stone cubes scarcely distinguishable from the mountain slopes on which they stand. Close ranks of white tents shelter indefatigable workers, these fervent "Haluzim," men and women who, pick and mattock in hand, make a road, a house, a field, a country. This town, born yesterday and growing without pause, is a living symbol of their febrile activity. New and curious sights these are in the Holy Land, as surprising as the long forgotten sonorities of the old Biblical tongue, awakened from the dead and living, flourishing amazingly in school, shops, and streets.

Such happenings in a land of ancient and eventful past create a human problem of great magnitude. It is well to ask how this movement is being realized under our eyes: what are the means by which it is being accomplished, what its elements and its resources for the future?

But first, what is Palestine? The Biblical land of abundance, overflowing with milk and honey, today presents itself in harsh and arid guise: the trench of the Jordan, floored with sand and sun-baked mud left by the retreating waters of the Dead Sea, an unnatural sea hostile to life; the long mountain ridge from Judea to Lebanon, barren summits, livid and mournful, treeless, the terraces of former cultivation long since crumbled, only an olive here and there clinging by a miracle to the loose stones of the limestone slopes; only in the ravine bottoms a little soil to support precariously the luckless Judean shepherds and their meager flocks of little black sheep; the coastal plain where sand replaces rock and under a devouring sun becomes desert where water is lacking or elsewhere is transformed into unhealthful marshes. Only the valleys (Jezreel or Esdraelon) are green and rich, the irrigated regions (plain of Sharon) and the banks of the Sea of Galilee, picturesque and smiling.

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[3] Council of the League of Nations, done at London the 24th day of July, 1922.

[4] American endorsement. Resolution unanimously passed by the House of Representatives on June 30, 1922.

[5] Exclusive of 5000 returning war refugees. Also exclusive of this figure the total net immigration is estimated at 71,000. Memorandum submitted to the Secretary-General of the League of Nations for the information of the Permanent Mandates Commission, October, 1925. The text of the Memorandum is printed in the *New Judea* (London, June 11, 1926.)

Zionist colonization, according to the plan which has been in operation since about 1920,[6] has penetrated chiefly in the following regions: Jaffa and its environs in the fertile plain of Sharon, designed as a base for further spread and as a focus of relations with the West; the northern coastal plain; northern Samaria and Galilee (the plain of Esdraelon and the valley of the Jordan) with the greatest "possibilities"; and the nucleus, Jerusalem, more important for its situation and spiritual significance than for its resources.

The whole can be described as a triangle, the "Zionist triangle." "On the coastal plain the industrial town, the port of commerce. This is Tel Aviv, strong materially. In the plain of Esdraelon the harvests of corn and social justice: this is the Emek, strong in brotherhood. At the summit of Judea, inhuman but burning with spirituality, the house of the soul."[7]

Tel Aviv, the Industrial Settlement

Tel Aviv, "Hill of Spring", is the precious jewel, the gem most brilliant by size and luster in the Zionist diadem. Its mayor describes his city as the "most progressive in the world," and in fact it is so very young that it does not yet appear on the standard atlases and the excellent English war maps and post-war maps which are not Zionist documents. By the side of Jaffa, the old headland city, picturesque and dirty, Tel Aviv has sprung up in a few years. In 1909 here were only sand dunes along a low and narrow coast, a splendid beach where the sun shone on rolling, surf-bound blue waters, a desert no less than the vast sandy stretches from El Arish to Gaza.

It was here that the nascent Zionism laid, timidly enough, the first stone of the first Jewish town of the new Palestine. The first houses were built in 1910–1911. The population numbered a bare 900 in 1913, and there was little increase until 1920 when a great effort was put forth. In 1920 the number rose to 10,000; in 1924, to 25,000; in 1925, to nearly 35,000. In 1921 the town covered 3700 acres, in 1924, 8600. In 1925 there were 3000 houses, and, as it is said, "three are finished each day that God gives." It suggests an immense building yard where under a burning sun endless convoys of camels carry limestone blocks of a dazzling whiteness. Everywhere dust, plaster, sand, cries, grinding of saws, hammer blows, a feverish and startling activity in the accustomed somnolence of the East.

Tel Aviv is entirely independent of Jaffa. It has a municipality, an administration, and an autonomous police of its own. Under the

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[6] Data obtained from Tel Aviv, Jewish Agency, April, 1925.

[7] Jean Richard Bloch: La Nouvelle Sion—Intransigeant, Paris, May 29, 1925.

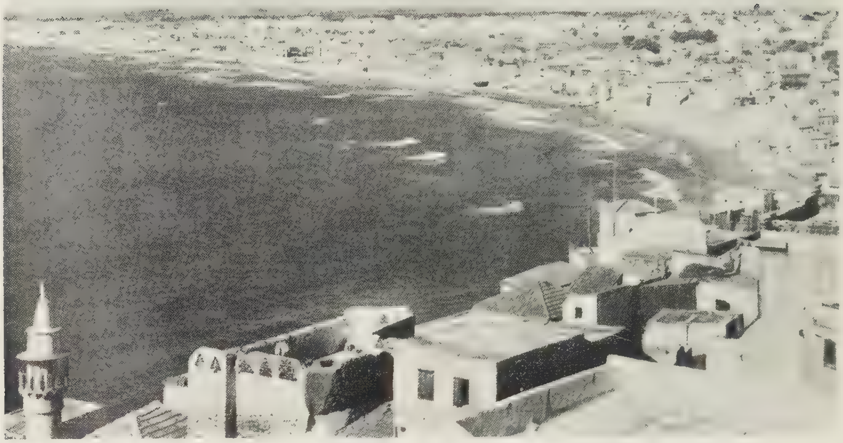

FIG. 1—General view of Tel Aviv from Jaffa. (Photograph by Eliahu Bros., Jaffa.)

direction of its mayor, a distinguished student of civics and a former pupil in a French university (Montpellier), its prodigious building boom is strictly directed and regulated. "The Hill of Spring"—the name is purely symbolic, for the region is absolutely flat and spring is short and hot—far from becoming the architectural Babel that its first buildings, 1910–1920, would seem to forecast, today presents the aspect of a modern city: straight streets and long, tree-bordered avenues that divide into almost regular blocks the several quarters each with its own characteristics and regulations. In the residential quarter, Nice or Palestinian Vichy, each cottage is embowered in a garden. One-third of the area only has been built upon; no houses front on streets: it is a garden city. On the sea front are the hotels, the pensions, hospitals, playgrounds, even a casino. Towards Jaffa is the quarter given over to light industry where the domestic trades (manufactures of hats, clothing, shoes) find inexpensive accommodations in the great municipal buildings, well lighted and ventilated workrooms with water, electricity, and often power from compressed air. In these more crowded quarters where greenery is rarer, though not absent, the atmosphere is scientifically disinfected by the municipality during the evening. The two main thoroughfares—crossroads, one leading to Jaffa, the other to the sea—constitute the business section of attractive and flourishing shops. Innumerable signboards, varied and picturesque in design, swing over the streets, reminiscent of the ghetto. There are many book shops (I counted seven large and three small ones in one street) and music shops. There are elegant hairdressing establishments: in contrast not a saloon. It has been remarked that "it is easier to buy a book or magazine than a drink";

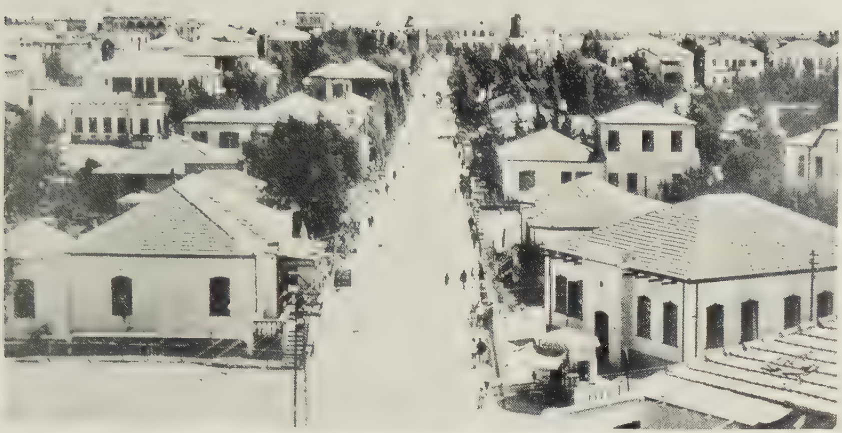

FIG. 2—A street in Tel Aviv. (Photograph by Eliahu Bros., Jaffa.)

it might be added "if one speaks Yiddish or German." Arabic, English, and French, constantly used throughout Palestine and in near-by Jaffa, have no place in the new Zion.

The mushroom town, now stretching over a space of five kilometers, soon to be seven, already has suburbs where the roads run towards the sea to the north and east—Nordia and Borüchov; and the heavy industries are generally localized in these quarters far from the center of the city. No less than 130 factories, mostly spinning mills of Austrian origin, are in full swing, and other large plants have more lately been established. An important tannery has been installed at a cost of £40,000; silk mills, chiefly intended for making crêpe de Chine, have come from Vienna; brickyards, furniture factories, a chocolate factory, and a large silicate plant (The Palestine Silicate Company, capital £75,000) each employing several hundred workers, have grown out of actual needs of construction.

All these establishments are run by electricity and on the most modern lines. Light and power have for some time been furnished Tel Aviv and Jaffa from the powerful transforming station of the Palestine Electric Corporation (capital £400,000), the first Zionist industrial organization authorized by the English government. This station is installed some little distance away on the streamlet Auja, which also furnishes water to the city.[8]

In the town the central electric station (1200 kilowatt power) is a building of pure Jewish architecture. So also is the lyceum, the most prominent building, begun in 1909 and today accommodating

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[8] Under the energetic director of the organization, P. Rutenberg, similar works have more recently been undertaken in the Haifa section.

600 pupils. A railway was opened in 1921: it runs only to Jaffa, however, and adds but little to the already numerous means of communication by autobus and horse trams between Tel Aviv and its nearest neighbor.

The "Hill of Spring" earnestly supports education. There are 22 primary or upper primary schools, 6 special technical schools, 3 music schools, and 13 kindergartens, while there are 8 daily papers published in Hebrew. Hospitals and dispensaries jealously guard the health of the citizens. Pride is even taken in the municipal watering carts, for sprinkled streets are a highly appreciated luxury in this realm of sand and dust.

The rapidly growing town counts—and perhaps this explains its growth—an important majority of workingmen, 32 per cent of the population gainfully employed; then come traders, 31 per cent; municipal employees and functionaries, 24 per cent; teachers, 3 per cent; the liberal professions—doctors, lawyers, and, most numerous, architects—10 per cent.

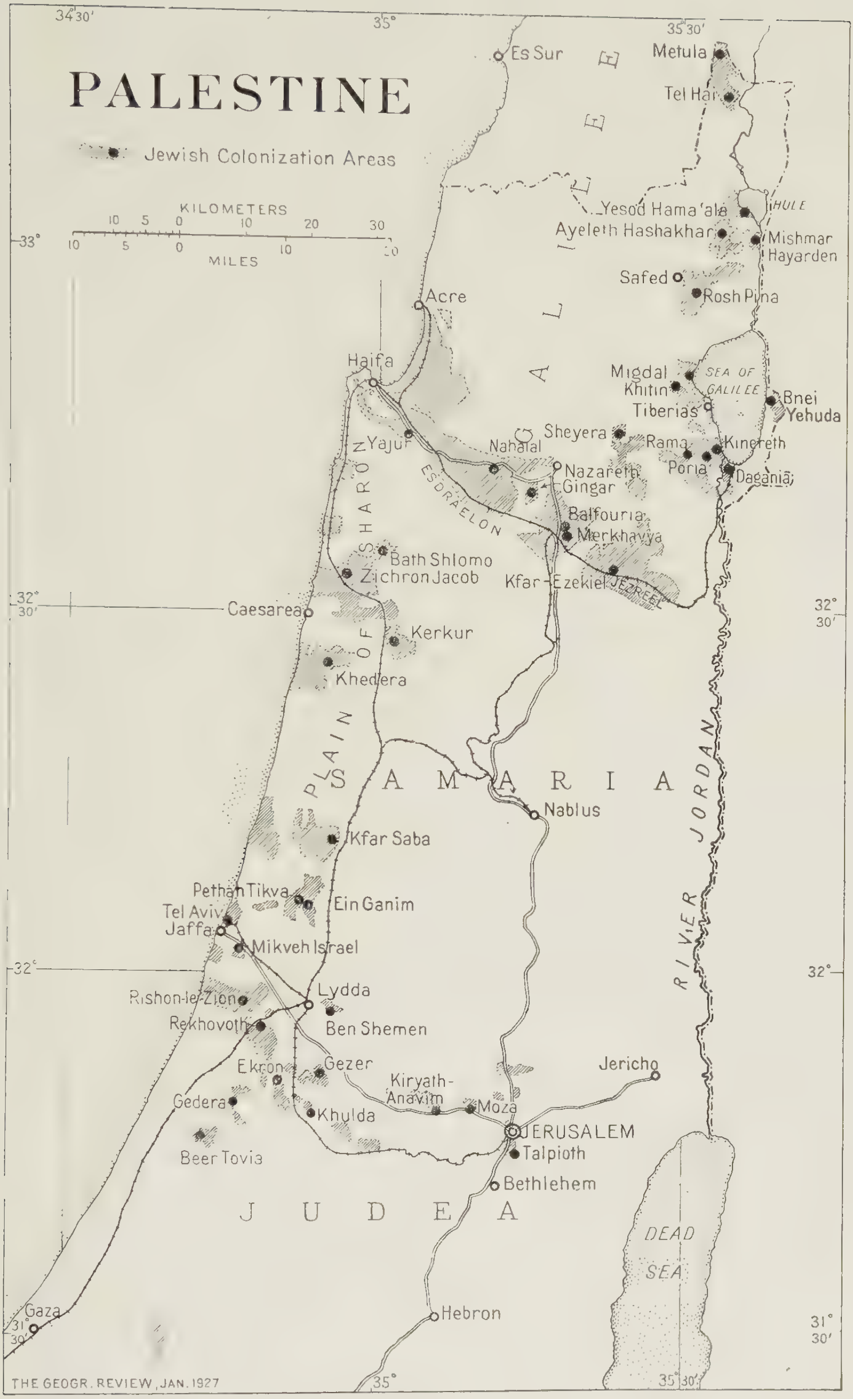
It is a striking thing, however, that the marvelous orange groves occupying a belt 6 kilometers broad round Jaffa are mostly in Christian hands and do not offer employment to the Jewish population. Furthermore, such Jewish proprietors as exist will employ their fellow religionists only under compulsion. They much prefer the Arabs, who work longer and for less money; wages at Tel Aviv are high because artificially stimulated.

Outside of construction works and the manufactories the only opening for the inhabitants of Tel Aviv is trade, and even here there are difficulties. It is not practicable to establish a port by the side of Jaffa, whose own existence is precarious enough. The coast is difficult of access—because of rocks and bar and surf ships cannot approach the harbor, and goods have to be lightered—and an economic hinterland is lacking.

But the "Hill of Spring" advertises itself as the hope of Jewish trade. Already many of the shops of Jaffa (40,000 people) have been deserted for the more attractive and better stocked shops of the Jewish city. There it appears is the future of Tel Aviv. The mayor's dream is to have 100,000 inhabitants in ten years or, better, in five years and to become in the future the metropolis of Asia Minor. A somewhat ambitious dream; but it is a fine thing to have already created, in such a situation and under such conditions, so beautiful and prosperous a city.

The Agricultural Colonies: In the Maritime Plain

Not all the colonies of the Jaffa group have enjoyed the vigorous growth and success of the "Hill of Spring." Forty years ago in this



THE GEOGR. REVIEW, JAN. 1927

FIG. 3—The Jewish colonies in Palestine from maps of the Keren Hayesod and the Keren Kayemeth. Scale of map 1:1,150,000.

same region Russian Jews, fleeing the pogroms, founded the first colonies. Their beginnings were difficult.[9] To the north Pethah-Tikva, "Door of Hope," was planted on marshy and unhealthful ground; to the south Rishon-le-Zion, "First in Zion," on stony and waterless land. These unhappy "Lovers of Zion," as they named themselves, trusting too much in the Biblical traditions of the land, decimated by fever and destitute of resources, could not have held out but for the beneficent help of Baron Edmond de Rothschild. By his financial aid sandy soil has been irrigated, marshes drained, wells dug, trees and vines planted, houses built, taxes paid.[10] Thus the verdant gardens of olive and eucalyptus are accounted for, the vineyards, the orange and citron groves, the indispensable reservoirs, veritable "chateaux d'eau," diffusing life and marking the flourishing colonies of today.

The "Door of Hope" now opens on a garden of more than 3700 acres of delicious fruited orange trees. Many thousands of Jews live on it, though it is far from comparable with the famous groves of Jaffa. Near by are Kfar Saba and Ein Ganim and, overlooking the road and rail to Jaffa, Mikveh-Israel with its important agricultural school. The 750 hectares of Rishon-le-Zion have become a single vineyard whose product has acquired renown for its quality and made good its name as a first fruit of Jewish endeavor. It has an important export trade. Neighboring groups, as soon as they obtained water, have also planted the vine on these foothills of mountainous Judea: Ben-Jacob-Rekhovoth, "Whom God Increaseth," stony but sunny, where the eucalyptus, whose wood is much in demand for orange boxes, has conquered the low sandy stretches. At Ekron the red roofs, seen from the Jerusalem-Lydda train, are lost in fruit trees, almond and olive. Other little groups are strewn along the sandy road from Lydda to Gaza—Gedera, Beer-Tovia; and along the mountain road from Lydda to Jerusalem—Gezer, Khulda, Ben-Shemen.

That determination to conquer the wilderness the Zionist pioneers also brought to bear on the seaboard of Samaria, marshy and malarious. The cost was high: many memorial stones scattered about the fields recall the names of those who perished in the struggle, but the work of drainage has been accomplished in part, and many eucalyptus plantations are improving the salubriousness of the country. There is Zichron Jacob, "Souvenir of Jacob," at the foot of Mt. Carmel, in memory of Edmond de Rothschild and his father, who supported it; respectively west and east of the Haifa railroad are Khedera and Kerkur, and to the north Bath-Shlomo, maintaining at great pains the eucalyptus, olives, and vines which are their *raison d'être* if not their entire support.

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[9] Pierre Mille: Colonies juives et allemandes en Palestine, *Ann. de Géogr.*, Vol. 8, 1899, pp. 160–169.

The history of the colonies and their present status is discussed in A. J. Brawer: Il ripopolamento della Palestina con gli Ebrei, *L'Universo*, Vol. 7, 1926, pp. 533–565.

[10] Jérome and Jean Tharaud: *op. cit.*, pp. 142–145.

COLONIES OF THE EMEK

From Haifa there runs inland thirty miles or more to the southwest the plain of Esdraelon and the vale of Jezreel. This is the Emek, the plain traditionally famous for its crop and its flowers, whose praises have been sung from David to Renan and Loti. In fact it is a narrow passageway, terribly hot, humid, and unhealthful. The Arabs hold the heights, the Bedouins pasture their flocks thereon. Or so it was until 1920. Now it may truly be described as the "valley of realizations" with the most developed type of colony and an ideal organization of equality and justice "discarding the reigning forces of western civilization."

Each farmer is a tenant of Israel, the Jewish people being sole proprietor of the land; for the National Fund, supported by Jews all over the world, has bought bit by bit the sacred soil of their ancestors (35,000 acres in Emek). The land is allotted only on temporary title or lease. Each family cultivates as it pleases, by itself or grouped with others under coöperative or communal form. There the people have lived, happily and prosperously for the year or two since their arrival, without using any form of money. It is the Holy Land of collective work.[11] The great coöperative organization which, in principle, buys all the products of their communal industry furnishes according to need clothing, equipment, seed, foodstuffs. Naturally no colony is as yet self-supporting, and the dream of some groups of communists, as for example, Ain Harod near Balfouria, to be sufficient unto themselves, is unrealizable. Some scattered islets, it is true, are more or less fringed with verdure and yellowing harvests—wheat appears to do well in Emek—but they make all the more visible and heart-rending the desolation of the rest and recall at what a price these white houses, these cornfields, these rare olives and eucalypts have been brought into existence. Although aided by all the equipment and methods of modern agriculture, the first pioneers of Emek have had a terrible struggle. But nothing deters or discourages them in this mystic valley, the first land in the modern world to be cultivated and populated solely by Jews, the first wherein the laws of Zion can be realized.

From Haifa to the Jordan the settlements are strung along. Here is Kfar-Ezekiel, where 48,000 trees have been planted, a nucleus of bungalows, stables, and barns from which radiate in all directions some 60 little farms hidden among eucalypts, apricots, and orange groves. Gingar has planted 3000 trees. Nahalal is a swarming hive amid 40,000 newly planted trees; Balfouria,[12] the "American colony," so named because all the agricultural implements were sent from America by the Union of Jewish Workers, stands proudly among its almond trees, an important group of pretty white houses with picturesque sloping roofs. Under its shadow is a newcomer, Benjamina. Merkhavya, "Place of God," includes some large farms.

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[11] Jean Richard Bloch: *op. cit*

THE JORDAN VALLEY AND JERUSALEM

From the Emek we pass to the Sea of Galilee, the beautiful lake whose blue waters, restless and sparkling, are dotted with the sun-bleached sails of the daring Galilean fishermen. It is easy to understand the seduction of this rich and smiling Tiberian region. For centuries the banks of the lake have supported a swarming mass of humanity, happy and prosperous. There are native Jews, Christians, Arabs; all the peoples who are represented in Palestine. Hence the newcomers who have succumbed to the charms of the region have been compelled to take what was left. There was little to choose from: the small Migdal, the old Magdala, founded in 1910 by the Russians and since augmented with new elements, some sparse groups about Tiberias, and lastly, at the south-southwest, Kinereth, stretching into the mountain since the banks of the lake are too narrow and too densely peopled to offer more accommodations. And inland from the lake lie Poria, Rama, Khitin, Sheyera on the road from Nazareth to Kfar Tabor; to the south of the lake is Dagania. East of the lake on the Trans-Jordan frontier is Bnei Yehuda. The apex of the Zionist triangle stretches along the upper Jordan to the frontier of Syria. Clinging to the mountain sides or seeking refuge in the valley are some dozen little colonies which it is hoped "God will enlarge": perhaps, one may add, if the physical conditions now none too good are improved. The "Keystone," Rosh Pina, between Safed and the Jordan, was founded by Russian and Rumanian Jews and, like Rishon-le-Zion and Zichron, saved by Edmond de Rothschild. Towards the north are Mishmar Hayarden, Ein Zeitun, Ayeleth-Hashakhar, and Yesod Hama'ala—the last on a small lake, Hule (the Waters of Merom), with marshy and inhospitable banks.

Lastly Metula and Tel Hai, the "Hill of Life" directly north, have been located for reasons more political than economic. They have suffered from the incursions of raiding Bedouins, and their colonists, mostly German, have undertaken vigorous reprisals. A legend even has sprung up around one of their number slain in 1919, a martyr to Zionism.

There remains the hardiest group—a group which does not fear to defy harsh Judea that it may find itself in the radius of Jerusalem.

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[12] Myriam Harry: Les amants de Sion, Paris, 1923.

Most of these colonies are still under construction and have not yet realized what their destinies will be. The oldest, and the most remote also, on the road to Jaffa is Kiryath-'Anavim, "City of Vineyards," where a hundred colonists are in coöperative association; then Moza and Talpioth, "Hill of Beauty"; others are simply, as it were, ghettos surrounding the Holy City.

The Basis of Zionism

The accomplishment of such a result as this Jewish colonization of Palestine needs explanation: and the explanation is money. Money is in fact the basis and moving power of Zionism. More necessary than faith, it is money alone that has permitted this miracle, the transplantation of more or less poverty-stricken people on a land so inhospitable.[13] From 1919 up to March, 1924, there had been spent in Palestine for and by the Jews £7,000,000 sterling, and money continues to be spent.

Immediately after the recognition of the Palestine Mandate by the League of Nations the Jewish Agency was founded, whose creation was stipulated in Article 4.

> An appropriate Jewish agency shall be recognised as a public body for the purpose of advising and co-operating with the Administration of Palestine in such economic, social and other matters as may effect the establishment of the Jewish national home and the interests of the Jewish population in Palestine, and, subject always to the control of the Administration, to assist and take part in the development of the country.
>
> The Zionist organisation, so long as its organisation and constitution are in the opinion of the Mandatory appropriate, shall be recognised as such agency. It shall take steps in consultation with His Britannic Majesty's Government to secure the co-operation of all Jews who are willing to assist in the establishment of the Jewish national home.

Then the financial organization of Zionism took form. In the spring of 1918 the Zionist World Organization had launched the "Restoration Fund," which in June, 1920, was enlarged, becoming the "Palestine Immigration and Colonization Fund," "Keren Hayesod." This official financial organ, sanctioned at the Zionist conference in London, was registered in London in March, 1921. From April 1, 1921, to March 31, 1926, the Keren Hayesod alone expended considerably over £2,000,000 sterling in Palestine. Its work is twofold: it is in the first place general collector from Jews the world over, and steady propaganda is carried out by its two chief agencies in London and New York. In the second place it is the distributing agency among the various Jewish activities in Palestine that solicit help. In its transactions the Keren Hayesod has lately been aided by the General

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[13] In 1924 and 1925 there was a considerable increase in the number of immigrants of the "independent means category." Taking the year 1925 as a whole, it is estimated that private capital thus introduced into Palestine amounted to £E.2,000,000. Memorandum cited in footnote 5.

Mortgage Bank of Palestine Limited, whose capital, £200,000 has largely been obtained in America. The Mortgage Bank has concentrated help on Tel Aviv where it has assisted in the building of 225 houses.

Up to now support has been principally given to agricultural colonization. From April 1, 1921, to March 31, 1926, £680,000 has been devoted to the agricultural colonies, 31 per cent of the total expenditure. Of the 100 existing colonies Keren Hayesod is "responsible" for the foundation and start of 44, in all 45,000 acres (185,000 dunams). It has also founded 4 agricultural experiment stations[14] and nurseries for at least 750,000 trees. To prevent loss of time and unnecessarily onerous work on the part of the community a number of immigrants have, through the care of the Keren Hayesod, received agricultural training in the countries of origin.

Besides the material there is the spiritual side. The Keren Hayesod almost unaided takes care of the vast and quite modern Jewish school system in Palestine: 20 per cent of its funds are expended thereon. Teaching is carried on in the language of the Prophets. At present there are over 600 teachers to 16,000 pupils distributed in 168 urban and rural schools, comprising 69 kindergartens, 86 primary, 3 secondary, 3 normal, and 7 technical or professional schools. The Hebrew University on Mt. Scopus, Jerusalem, formally opened in April, 1925, also owes two of its institutes, those for biology and chemistry, to the Keren Hayesod. Two others, microbiology and radiotherapy, are supported by the American Jewish Physicians Committee. The university has hardly yet begun to function in the usual sense, but it is hoped many young Jewish scholars will be drawn there as instructors and that ultimately there may be realized a center of Hebrew studies which will be the symbol of the resurrection of the spirit and the unity of Israel.

Awaiting this development the university is actively occupied with the health of the new arrivals, who, hardy or not, are always more or less affected by the climate and the endemic diseases of the East. The Hadassah, a Zionist medical organization, subventioned by the Keren Hayesod and the Joint Distribution Committee with the special coöperation of the "American Jewish Women," valiantly carries on the war against the anopheles mosquito and against trachoma, so general among the children. There are 17 Zionist hospital clinics and dispensaries functioning in Palestine, chiefly in the towns of Jerusalem (Rothschild Hospital), Tel Aviv, Tiberias, Haifa, Safed, and Hebron. Sanitary measures in the form of regular inspection and disinfection are carried out in the schools, the colonies, and the immigrants' ports of entry.

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[14] Special mention should be made of the farm school for young girls, subventioned by the Women's Zionist Association and the Keren Hayesod.

But it is not sufficient to organize along modern lines these corners of Palestine reconquered by the Jews: they must be peopled. The Keren Hayesod devotes a good part of its fund, 13 per cent, to the organization and encouragement of immigration. It is from Europe, especially central Europe, that the greater part of this new exodus has come: In 1925 the proportion of Jewish immigrants from Poland was 50 per cent; from Russia and the Ukraine, 23 per cent; from Rumania, 6 per cent; from Lithuania, 5 per cent. Since the Revolution in Russia the Jews, who once furnished the strongest quota of its emigrants, have not left in such numbers that country where they have gained equal rights or perhaps an advantage over the rest of the population. The majority of the immigrants in Palestine—and this is the weak point of the scheme—have nothing to lose in the venture and everything to gain, for they are assured of work. They become the Haluzim, builders of the country—roadmakers, farm laborers, factory workers in the towns; or if they arrive with their families they are advanced a little money and land.

The Keren Hayesod has charge of all arrangements: the departure from Europe and the arrival at the great camps of Jaffa and Haifa where the immigrants are quickly placed. Distribution is accomplished with the efficient collaboration of two great financial societies, the Jewish National Fund (Keren Kayemeth) which buys the land in the name of the Jewish people and the Palestine Land Development Company; of various Jewish banks, the Workmen's Bank, the Jewish Colonial Trust, the Anglo-Palestine Company; and of private capital[15] which numerous Jews do not hesitate to furnish.

THE FUTURE

But—for there is a but! If the marshes are drained and the deserts irrigated, can we permanently transform into an agricultural folk these people who have never known the feel of the earth, never heard the call of the land? What of the farms and camps and tents in which there have been planted fervent intellectuals, illiterate tailors and shoemakers of the ghetto, and exalted students who would rather break stones along the highway than attend to the cares of husbandry, under the pretext that thus they build better the new Palestine? What a difference between their feverish activity, a little out of harmony with nature, and the cheerful serenity of the citizens of Tel Aviv, traders born to be traders. Let it not be forgotten that at present not one of the colonies is self-supporting; nor that boats are leaving full of immigrants whose hopes have been frustrated. It is said that in 1925 nearly 2000 returned whence they came: while statistics of arrivals are well kept, there are no comparable figures of departures.

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[15] From 1921 to 1924 the total of private capital engaged in industrial and commercial Jewish enterprises in Palestine is estimated at £1,400,000.

This perhaps is why the native Jews, the 60,000 Palestinian Jews, regard the newcomers curiously and without much sympathy. They do not regard as brothers these young men, dressed in Anglo-Saxon style, with khaki shirt open at the throat, knickerbockers, long hose and stout shoes, who, bareheaded, escort young women in white with short skirts, bare arms, and bobbed hair. The old Jew of the caftan, "wailing at the Wall," distrusts these rebuilders of Jerusalem, who arrive without Talmud or Torah, not to weep, but with Karl Marx as their evangelist. They mistrust their developed and modernized faith; and, in spite of the common religion, the groups remain distinct, strangers, even hostile. Furthermore, the national character of these newcomers is marked. In Palestine it is curious to note that the Jews among themselves not only remain Ashkenazim, from northern and central Europe, and Sephardim, Mediterranean, but Polish, German, Rumanian, etc. It is quite easy for an observant person to tell the country of origin of these many types where community of religion and language are the only common factors of understanding.

The most devoted Jews themselves wait with a certain, slightly anxious curiosity the outcome of this "experiment," as they call it. The diversity of the fundamental elements constituting the colony and especially the different sources—Anglo-Saxon capital, German material and intellectual organization, labor chiefly Slav—have been the forces up to now: will it be always thus?

And how will it be—and this is the vital point—if the heavy funds needed to maintain this delicate equilibrium should for some reason not be forthcoming?

SOUTHERN RHODESIA

A WHITE MAN'S COUNTRY IN THE TROPICS

Ethel Tawse-Jollie

IN Southern Rhodesia we have a country unique in many respects. Here is a community of white people living in the tropics and leading a life which is a compromise between that of such countries as India and a true European democracy. Climatically and politically it is a white man's country: socially it is a white aristocracy with a black proletariat. It is, of course, not altogether a new experiment in social evolution, since similar problems are encountered in South Africa; but contrasts are more pronounced in Rhodesia because the evolution of both white and black society has been comparatively much more rapid. We have covered, thanks to railways and telegraphs, more history in thirty years than the Cape covered in two hundred. Our white people have passed in a few years from the pioneer stage with its roughness and hardships to the era of up-to-date hotels and motor cars.

It is perhaps well to remind the reader of the distinction between Northern and Southern Rhodesia. Southern Rhodesia is a self-governing colony with a white population of 40,000, whereas the northern state is governed by the British Colonial Office and has only 2000 to 3000 white inhabitants, of whom many are civil servants. The Zambezi, which divides the two Rhodesias, is more than a physical boundary. There is good reason to think that it delimits the area in Central Africa nearest to the equator which can be regarded as a white man's country in any true sense, and this although there may be, even nearer, isolated areas where the temperature is far from unpleasantly hot, as in Kenya Colony for instance.

Occupation of the Country

Southern Rhodesia originally consisted of two native states, Mashonaland and Matabeleland, and these names are still used to indicate what are now merely geographical and racial divisions. In 1889, at a time when it looked as if a German cordon might be drawn right across the continent, Cecil Rhodes organized the British South Africa Company. Its purpose was to develop concessions acquired by him from the Matabele king, Lobengula, and bought from other concessionaires; and armed with these he sent a force of five hundred picked men as police and pioneers into Mashonaland. Two years

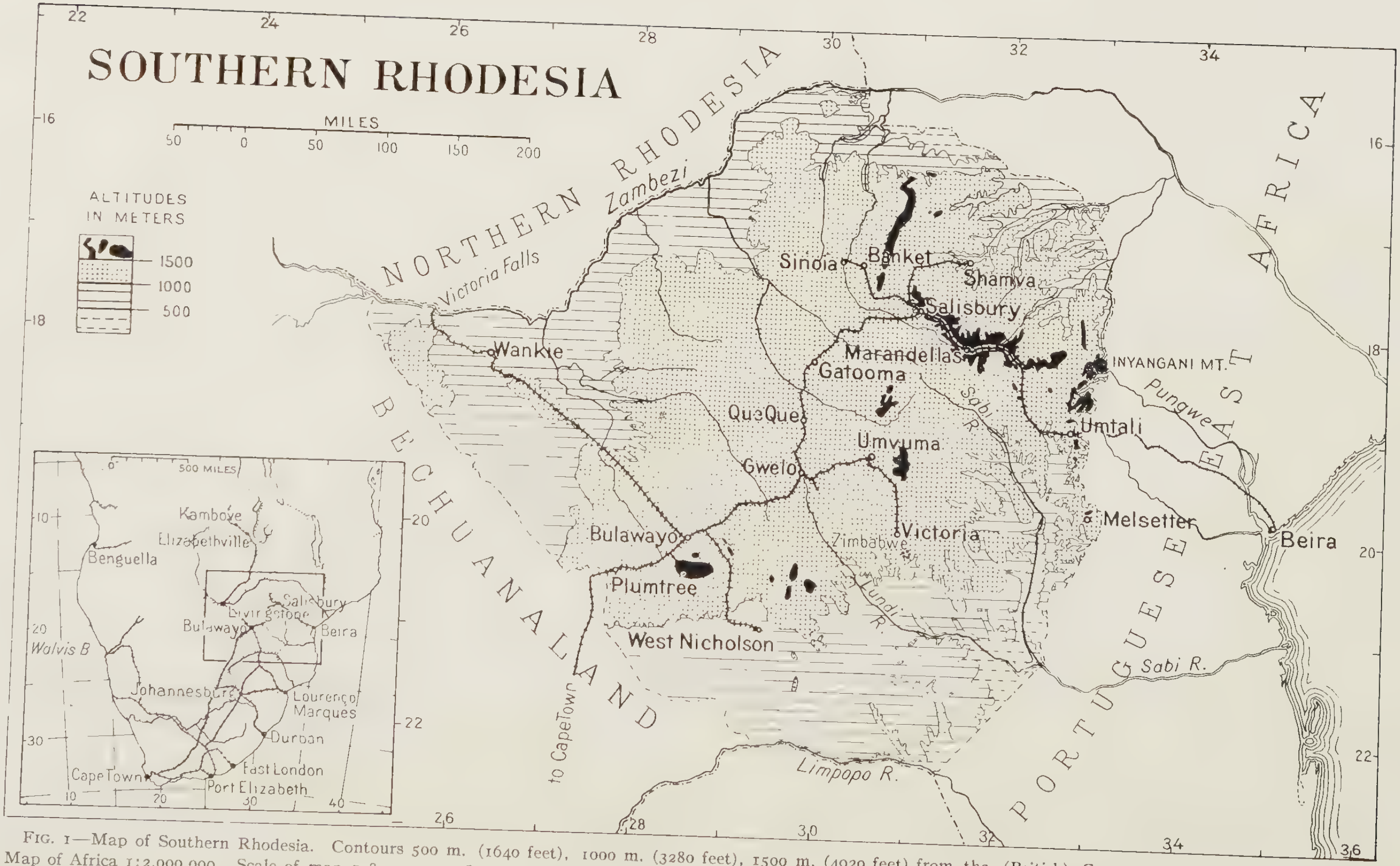

FIG. 1—Map of Southern Rhodesia. Contours 500 m. (1640 feet), 1000 m. (3280 feet), 1500 m. (4920 feet) from the (British) Geographical Section General Staff Map of Africa 1:2,000,000. Scale of map 1:8,000,000. Inset map (scale 1:75,000,000) shows rail communications with the exterior.

later they invaded Matabeleland and drove Lobengula into exile, where he died. They were then in possession of a large, fertile, and promising country with every prospect of finding a new reef. Nothing but such a possibility could have drawn a business company into such an undertaking; but as months went by and the rich reefs were still undiscovered, the situation became exceedingly difficult, for the resources of the company were limited and their commitments practically unlimited.

No help of any kind was forthcoming from the Imperial Government except that, when the withdrawal of the police force to take part in the Jameson raid and other errors of policy had led to a native rebellion, they sent troops to help establish safety but on the distinct understanding that the financial responsibility did not rest with them. This rebellion in 1896–1897 and the Boer war of 1899–1902 were serious interruptions to the settlement of Rhodesia; but the war, which had taken so many men away, subsequently helped to introduce newcomers both to the South African colonies and to the less known territory of the British South Africa Company. Many men who came out with the volunteer corps to the war were bitten with a taste for Africa and returned later as farmers and colonists. One or two schemes of community settlement were launched, in the Free State particularly; and these were assisted by the policy of Lord Milner of developing agriculture by improved stock, agricultural and experimental schools, and other measures calculated to improve the antiquated methods of the Boers.

From that time to the present there has been no systematic attempt to bring in fresh European blood, although every one agrees that it is highly desirable in view of the existing disproportion between black and white. Lately a society called the 1820 Settlers Society has been at work in the Union and has introduced some six hundred men, each of whom must have an available capital of £1500; but there appears from the statistics at hand to be a considerable leakage of British-born from the Union of South Africa at the same time, and a regrettably large percentage of the immigrants come from southeastern Europe. Southern Rhodesia gets quite an appreciable stream of immigration from the farmer class in the Union.

A SOVEREIGN STATE

In 1923 Southern Rhodesia became a self-governing colony of the British Empire, a sovereign state under the King. She has her own parliament, at present of one chamber with thirty members; and she maintains her own defense force, a white mounted police and a volunteer organization as a second line of defense. The Constitution[1] granted gives her full control of all affairs except that legislation as to natives and mineral rights and railways is reserved for the consent of the British Government. The first reservation is in accordance with British tradition in South Africa, the latter have due regard to interests of the British South Africa Company in these developments.

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[1] The Constitution is given in the first official Year Book of the Colony of Southern Rhodesia, Salisbury, 1924.

The Country Itself

A word as to the country itself. The colony is approximately 152,000 square miles in extent; and of that, roughly, one fourth is situated on a high and narrow plateau (the high veld) which runs from the Bechuanaland Border in a northeasterly direction through the country at an elevation of over 4000 feet and links up on the eastern border with a mountain range of even greater height, running up to 6000 and 8000 feet. An important spur runs north through the Umvukwes and links up with the Zambezi escarpment, which at varying altitudes runs along the north of the colony. The rivers in their middle courses have eroded deeply into the plateau producing a country of diversified relief, the "middle veld." "Middle veld" and "high veld" together constitute the bulk of the country, the "low veld" of the Zambezi, Limpopo, and Sabi basins being of limited extent. The lowest point, where the Limpopo crosses the boundary into Portuguese East Africa is 660 feet above sea level.

The drop to the Zambezi on the north and to the Limpopo on the south and also to the Sabi on the east is abrupt, and the tributaries running into those rivers have valleys that contrast in altitude and temperature with the plateau in their immediate vicinity, so that one cannot envisage Rhodesia as sharply divided into high and low, temperate and hot country. For the greater part of the year Rhodesia enjoys climatic conditions approaching the ideal, and this is true not merely of the high plateau but of many parts of the lower country where wind and rainfall contribute to temper the heat of the sun. The only parts of the territory where tropical heat is felt are the Zambezi and Limpopo valleys and the northwestern district (Wankie).

The seasons are two: winter, which lasts from April to September, being coldest in June and July, and the rainy season which begins with hot, thundery weather in October and cools rapidly from December onwards. A distinguishing feature are the cold nights which, both in winter and summer, are lower in temperature than those of most other regions with a similar day climate. Madeira, for instance, has a mean temperature of 65° F.; Southern Rhodesia a temperature of 66° at 4000 feet and 71.5° at 2000 feet; but the minimum temperature both at the coldest and hottest times of the year is lower in the colony than in the island.

The mean annual rainfall is 28.7 inches: on the east the figure is nearer 40 and on the west 20, and some districts bordering on Bechuanaland get less than 15 inches. At the time of writing (March, 1926), while the eastern border has had heavy rain and the Beira railway is flooded in an unprecedented manner, Bulawayo on the west is praying for rain. However, compared with other parts of the sub-continent the rainfall is stable (the standard divergence from the mean is 7 inches), and droughts are not so frequent as they are farther south. Rhodesia also possesses a number of large permanent rivers, and where such are not found water is easily obtained near the surface by wells and boring.

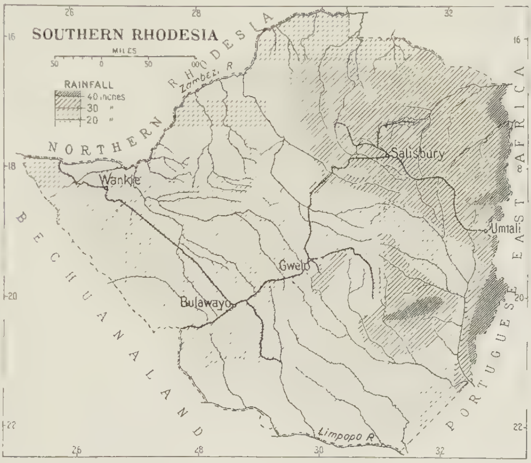

Fig. 2—Mean annual rainfall of Southern Rhodesia. Scale of map 1:13,000,000.

Population Density

It is usually remarked by visitors to Rhodesia that she is very English as to social atmosphere; and this is partly because they come through a country where, owing to a dual nationality and two languages, this effect is not produced. In reality her population is about equally divided, as to adults, between home-born and the South-African-born, and she has an appreciable contingent of Australasians as well. South Africa, after over two hundred years of European colonization, has a white population of 1,250,000 and 5,500,000 natives; Southern Rhodesia, after 30 years, has 40,000 whites and 860,000 natives.

It is customary to speak of these African countries as being sparsely inhabited, but in fact they compare favorably with many other "new" countries. Australia has an average of 1.53 persons, Canada 1.90, New Zealand 9.63, the Union 12.63, and Southern Rhodesia 5.87 to the square mile. Nor is it the case in Southern Rhodesia that the African population is increasing in greater ratio than the white, as might have been expected now that they enjoy peace and are cared for in famine and in sickness whenever possible. For Europeans the mortality is low: the death rate per thousand (unadjusted for age of population) was 12.6 for 1911–1920. The birth rate (unadjusted for sex ratio) was 27.74 per thousand, one of the highest in the Empire. There are now some ten thousand white Rhodesian-born children in school, and in appearance they do not differ from the home-born, except in one or two places.

Native Reserves

It may very well be asked why settlement in such a desirable country has been, comparatively speaking, so slow. There are towns in Canada and Australia which were founded at the same time as Rhodesian settlements and which now have a larger white population. The point is that one cannot regard only the white population in this question. Very large areas, amounting in all to over twenty million acres, have been set aside permanently for reserves in which the natives live on a sort of communal tenure. Although in some cases tribes have had to be moved some little distance from their ancestral homes, this has not been done to any great extent nor are the reserves the poorest quality of soil. Still it happens, very largely from reasons connected with the primitive methods of agriculture, that some reserves are not likely to be adequate for the increase of population; and here the government has been trying to improve the output of the land by boring for water and by teaching better methods of cultivation. A commission on native lands has just reported in favor of setting aside considerably more land and permitting natives to acquire it by purchase—a right possessed by them at present but exercised very infrequently. The commission's proposals would make the European area approximately 62 per cent of the total, the native areas 37 per cent. The commission is in favor of a segregation policy, which involves both races giving up their right to purchase in certain areas. Segregation is now the policy in favor in the Union, but it may be premature to consider it in Southern Rhodesia at present.

Besides the 516,335 natives living in these reserves (which are scattered all over the country and not concentrated in any special area) there are 150,650 living on white men's farms, 122,000 on unalienated government land, and 24,874 in compounds attached to municipalities. The last constitute an urban population which in many cases has lost all tribal sense or touch with the land. They are employed as servants, mechanics, drivers, and on every kind of semi-skilled and unskilled labor. Despite the protection afforded to the white mechanic by his trade union one sees in Rhodesian towns an increasing number of native chauffeurs, motor mechanics, carpenters, and other workingmen. In short, the country is really a white aristocracy with a class of highly paid white workingmen, who in their turn are employers of the real proletariat, the natives. The figures given are suggestive, as they show that close on 300,000 out of a total of 860,000 are living on land which is or may be occupied by European farmers; and of these, two-thirds are indigenous natives.

HINDRANCES TO SETTLEMENT

When, therefore, we inquire why the tide of emigration which, during the twenty years preceding the war, set so steadily away from the British Isles, has passed South Africa and Rhodesia by, we must remember that the average emigrant expects to be able to support himself by his own labor even if unskilled, at any rate for a time, until he has learned enough to become a landowner or employer. In countries where the native supplies raw labor this is impossible. Rhodesia admits no immigrant who does not appear to have either a job to go to, a sum of £50 for his own use, or some definite guarantee that he will not become a public charge. In the latter case he will be deported to his place of origin. A strict interpretation of other clauses of the Immigration Act is used to prevent the incursion of undesirables of any kind. When one adds the expensive railway journey which every immigrant must make to reach the Rhodesian borders, it is not a matter for surprise that the population has achieved quality rather than quantity. The government recommends that the farmer settler should have a minimum capital of £2000.

The racial reason has undoubtedly predominated in determining the course of development in Africa, but physical features are also unfavorable to rapid settlement. Had South Africa possessed great navigable rivers running to the south and east, her history would have been very different, for the problem of transport would have been simplified. As it was, her rivers presented a barrier to penetration of the hinterland, being raging torrents for a period of every year and dry chasms for too much of the rest.

Railways have now conquered these physical difficulties; but it must not be forgotten that the greater part of this huge continent was opened and colonized by ox wagon, which still remains the cheapest form of transport in many regions and the only one in some. Unfortunately there are cattle diseases encountered as one goes north which have from time to time swept almost the whole country. One such epidemic of rinderpest wiped out the whole of the transport to Rhodesia in her earlier days and forced Cecil Rhodes to hurry on the work of connecting the country with the outside world by rail and wire. At present there is a "fly" belt to north and east of the colony on the Zambezi and Portuguese frontier where cattle cannot survive, and in the Sebungwe district cases of sleeping sickness of humans have occurred. In order to maintain communications Rhodes had to construct a considerable length of line outside the company's territory, from Mafeking on the south and Beira on the east. The same controlling company built the line north to the Congo border, and the consequence is that if the Southern Rhodesian government desires to purchase the railways she will have to buy large sections that are not within her own borders; and the same difficulty attaches to any attempt to fix rates or control railway policy, though these are not insoluble problems.

RAILWAYS AND FARMS

The railways were designed mainly to serve the mining areas, but it is noteworthy that they also run through the heart of the main plateau and therefore give access to the healthiest part of the country. There are 1252 miles of railway; and, if 25 miles is taken as representing an effective crop zone, these lines serve a farming area of 62,000 square miles, or 40,000,000 acres. "Unfortunately," writes General Hammond, who recently conducted an inquiry into Rhodesian railway affairs, "a relatively large part of this area is of poor soil, and its crop production is further restricted by conditions of high altitude and moderate rainfall." He goes on to point out that within a 50-mile zone at an altitude of 2000 to 3000 feet are included some 20,000,000 more acres of rich alluvial soil, suitable for cotton and grain production on a large scale. These valuable statistics must be read in the light of what has been done in recent years on the sand veld, with a low rainfall supplemented by conservation of water by special cultivation. Formerly light soil was considered useless, but many changes are taking place in agricultural theory as the result of experiment. At the same time the development of cotton and tobacco on the lower areas is altering ideas as to the value of land that is still some distance from the railways.

General Hammond estimates that there are in the 25- and 50-mile zones some 25,000,000 acres of moderate fertility and 41,000,000 of rich soil; but the present acreage of European cultivation is only 300,000, and of native about 1,000,000. The main barrier to greater agricultural production has been and still is the cost of transport, which the settlers have laid to the doors of a profiteering railway. General Hammond does not accept the view that the railways have, hitherto, exceeded legitimate profits. The subject is highly controversial, and it is only necessary here to give General Hammond's conclusions, without any of the arguments that qualify it. He says "If land settlement is to be speeded up and the immense latent resources of the country developed, the problem of cheap transport must be solved."

There is no single way in which, so far as one can see, this can be achieved. In Canada railways went before settlement, but the results have not justified the belief that the example is a suitable guide for Rhodesia. At present there is still good land on the railway or in the 25-mile zone that has not been settled because it was alienated in early days to land and mineral companies. The total area thus alienated is close on 6,000,000 acres, and the chartered company's own ranching and agricultural land amounts to about 4,000,000 acres;

but, as the company is doing a considerable amount of development, this does not come into the same category as that of the other companies. Many of these have spent and are still spending considerable sums in the country in the mining industry; but they have held their land, without condition or charge, as a set-off against losses incurred in other directions, and with the frank intention of waiting for a rise in value. They are now prepared to sell, but it remains to be seen if their terms are sufficiently attractive. Meanwhile the government is on the point of introducing legislation to tax undeveloped and unoccupied land which will act as a spur not merely to the land companies but to many private owners who have taken up, often at a nominal payment, far more land than they can profitably employ.

Another method of advance may be found in the development of branch feeder lines, not necessarily railways, since motor transport is only now coming into its own. Much of the best land is awkwardly situated for railway communication, but experience has proved that road construction is cheap and easy if suitable drifts or bridges can be made to cross the rather numerous streams. Road bridges have hitherto been conspicuous by their absence, and a great deal of time and money has been wasted in patching drifts which periodically are either washed completely away or much damaged and cannot be crossed by motor traffic in the rainy season. Both in this respect and in the matter of roads and all public works the country was hampered by the fact that, under chartered company rule, no capital could be borrowed but revenue had to cover construction as well as maintenance.

As soon as Southern Rhodesia was granted self-government she entered the London market for a loan and has experienced no difficulty in raising all she needs; and up to date, after two years' payment of the services of her loan, she is in the position of not having had to impose a single extra tax. Her revenue, which has been growing steadily for the last fifteen years, will exceed the estimate for the current year by about £300,000, and this although it only touched the million mark in 1920. It encourages the hope that the government, which has proceeded very cautiously, will in the near future be able to deal with the question of communications in a more courageous spirit. Modern immigrants will seldom take themselves and their families out of easy reach of a railway even if crop farming (like cattle) could be made profitable under such conditions. A most important link in communications is, however, outside the government sphere at the present moment. Unless the port of Beira can be improved and the railway from there to Southern Rhodesia secured against such floods as in 1925 and 1926 rendered it impassable for several months of each year, Rhodesia must link her railways with those of the Transvaal via Messina and take her goods to Delagoa Bay. Bulawayo (via Salisbury) is 673 miles from Beira, whereas it is 1360 miles from Bulawayo to Cape Town. The construction of a connecting link would bring Delagoa Bay within more convenient distance of the main Rhodesian centers, and this will probably be one of the first new lines to be constructed. Another project is for a line running west to Walfisch Bay, but this could be built only with the goodwill of the Union and also (since it crosses Bechuanaland) of the Imperial Government. Although competent observers believe that it will come, the general impression is that the time has not yet arrived. A third route will run north and west with outlets both to the Congo and to the Atlantic at Lobito Bay; but, as at present planned, the former involves breaking bulk at least twice, whilst the distance by the latter is at present prohibitive for all but the most westerly districts. Nevertheless, it is apparent that Rhodesia will not always remain in her present comparatively isolated position and that her traffic will be a very valuable consideration for either of the routes to the coast (see Fig. 1).

Many persons are urging the government to embark on extensive schemes of land settlement. The writer is in favor of a policy of indirect rather than direct subsidization of settlement. Cheaper transport is the first need, and this should include assisted transport of suitable settlers from Great Britain. The expense at present deters many.

Land Purchase

Many different forms of land purchase and tenure have been tried in Southern Rhodesia, and there is no reason to suppose that we have reached finality. At present the basis is an agreement of purchase whereby the price plus five per cent interest is paid in half-yearly installments spread over 20 years. Obviously the price is the important question, and the land is graded according to quality and distance from rail, suitability for ranching or farming, or both. There has been a distinct tendency to overvalue land not merely on the part of the government—the British South Africa Company went to absurd length's in this respect except in cases where it was itself acquiring property—but on the part of private individuals; and the success of some experimental crop in a particular district will send up the prices at once to an uneconomic figure. There have been booms in land as well as in minerals. Land in the neighborhood of the chief towns is steadily rising in price and in the case of Salisbury by leaps and bounds, as a suburban population increases. Civil servants and professional men in the towns almost invariably become landowners and look forward to retirement on their farms, and this is equally true of men engaged in mining.

LABOR

Important as is transport in speeding up white settlement, it is not more urgent than the question of labor. Throughout South Africa, despite the large native population, this question is assuming acute proportions; nor is it likely to improve on the lines at present being followed. The Rand mines have from very early days been obliged to recruit their labor from the north; but it is surprising to find that Southern Rhodesia is also compelled to do this and has subsidized a labor bureau for many years past in order to secure a supply of alien labor. The number of natives in employment in an average year is 140,000; but of these 90,000 are aliens who come from the north to seek work in the colony. They are included in the census figures already given. Deducting them we find that 50,000 out of 170,000 adult male natives (allowing four persons to each family) are employed; but this figure is too high, as the "employed" include young boys, who are not "adult" in a European sense of the word.

It is a curious thing that Rhodesian labor goes to Johannesburg, while she recruits from Nyasaland and Northern Rhodesia, the attraction in each case being higher wages. Up to the present time this importation has resulted in a supply that has been adequate for the last few years; and wages, though rising, are still very low, 15 shillings a month for unskilled work and 5 to 10 more for drivers or head boys. The food ration is mealie meal with the addition of meat (quite a modern innovation) where it is cheaply procurable. The Labor Bureau boys get £1 per month and a standard ration of meat and meal and beans. They contract to work for a year and are not charged with tax. This tax, really a poll tax, is £1 a head for every adult man and 10 shillings for every wife after the first. Except a tax on dogs this is the only direct taxation of the native. To meet it he almost invariably chooses to work rather than pay it out of capital. His capital is mostly in the form of cattle, wives, and daughters, all of which are saleable; and to earn a wife, if his father cannot buy him one, he must go to the mines or to some other form of employment which will gain him £30 to £40 in a reasonably short time. With this he is set up for life. Cattle owners can pay for their wives in stock, but the reduction in the price of cattle has hit them rather hard lately. Although the words "buy" and "sell" have been used here, the custom of "lobola" is not really a matter of purchase, but of compensation to the father.

NATIVE DEVELOPMENT

The economic position of the native is obviously a very easy one, but it is built up on a standard of living that is hopelessly low. There is no margin for failure of crops, for unusual cold or rain; and every year there must be months of discomfort which in old age lead to suffering. The winter passes and the sun shines and the grain ripens. The native sits in the warmth, fills his belly, drinks the beer brewed by his women folk, and forgets the evil days; or rather, for he is essentially a fatalist, he says to himself that this is life. We have to remember that every man over thirty-five was born in the time of Lobengula, when providence and forethought were needless, and that practically all are pulled back to the kraal and its conservative influences by the dead weight of their womenfolk. There are people who think that the cause of labor shortage is the education of the native. They forget that were it not for the increased demands for clothing, better food, and an improved standard of living there would be no incentive for him to work at all, so long as he could raise the amount required by the taxgatherer. The early settlers had the greatest difficulty in getting labor of any kind; and the number of natives receiving education did not reach four figures until 1911 and increased by slow degrees until about 1918, when it began to jump and now shows another ten thousand every year.

The traditional "settler" view of the native is that he is not intended by his Creator to rise above being a hewer of wood and a drawer of water, in which capacity he is essential to the white man and to the development of the country. The traditional missionary view is that he is just as capable of development under Christian influences as the white man and has the same right to dispose of his labor or to live as he pleases. Yet the missions expect their converts to be ready to perform the functions of hewers and drawers for them, nor is it clear that they could continue their work without these services. Moreover, the missionaries, although some were pioneers, owe their continued existence and the possibility of increasing their work to the farmers, miners, and administrators who came in and gave the country roads, towns, industries, and a stable government. Christianity would not have reached the vast majority of these people except for the men who opened the country and freed their fathers from the tyranny of Lobengula. Granted, therefore, that the white man is necessary to the development of a civilized country and that he cannot live in it and develop it without the black man's labor, in what way can the relationship best be regulated for the advantage of both?

It is here, the writer ventures to think, that some, though not all, missionaries in Southern Rhodesia and elsewhere are inclined to go astray. They are so eager to protect their converts from the exploitation which, it must be acknowledged, would have taken place if some settlers had had their way, that their influence, perhaps almost unconsciously, has been in the direction of prejudicing natives against all employment except under mission auspices. The result has been pointed out in a very clear manner by one of the Nyasaland missionaries. For years past, Rhodesian employers, unable to get labor, have subsidized the recruitment of Nyasa and other northern boys and, as this missionary points out in a letter addressed to the Commission on Native Education (C. S. R. 20, 1925), the products of Nyasa missions today occupy the best posts open to natives in Rhodesia. As builders, carpenters, mechanics, gardeners, and domestic servants they are sought after and better paid than local natives because of their reputation. They are also employed on the best class of farm work and on mines, where a contract for a period of twelve months is an advantage. The object of the mission is to train them equally to be of service to the white man or to themselves. Nyasaland is not a white man's country, and the missions do not need to consider whether their pupils will compete with white mechanics; but this does not altogether explain the difference in their output.

It would be a bold missionary in Southern Rhodesia who would openly say that he trained boys for European employment; every one still maintains the pious fiction that the object is to send the native back to his kraal to carry on the traditions learnt in the mission school. Meanwhile, the cream of native employment goes to the aliens, and when the Rhodesian native begins to appreciate this he will feel dissatisfied. His main idea in seeking education is to increase his own market value, and it is often a shock to find that the white man does not recognize this. Boys who have learned a trade are in a better position, but they are few and far between and are often retained to work on the mission stations.

It must be realized that with the growth of European population the competition for labor will to a great extent protect the native from the undoubtedly too low wages of earlier days and the rate which is still paid in many districts; but when those wages are remembered it must also be remembered that the white man was and is struggling with the problem of development against almost overwhelming odds and that he has had no assistance worth mentioning from the vast majority of the natives. The labor problem was more acute at first than it is now, and it was solved only by bringing in (at great expense) northern boys and establishing a steady stream of labor from that source.

We can go even further. It is urged at all missionary congresses that the taxation paid by natives entitles them to a larger share of expenditure on such things as education, and it is true that their contribution to revenue is considerable; but it must be remembered that, on account of the rebellion of 1896–1897, the country has been forced by the Imperial Government to maintain a large and extremely costly white mounted police, whose presence would be unnecessary but for the native races. It is true there is now little chance of any further native trouble, but a police of this kind is easier to raise than to decrease; and at present their work consists almost entirely of native cases, notably prosecutions for non-payment of taxes. That the taxes are not too rigidly collected may be judged from the fact that in the current year the Government is £30,000 in arrears.

Native Industries

There is a section of opinion among the native administrators and missionaries that favors the development of native industries on the lines adopted in the West Coast colonies or in the mandated territory of Tanganyika, where European settlers are not encouraged and where the Government organizes the growth and export of native products, such as palm oil, cocoa, cotton, and coffee. The writer believes such a policy to be contrary to the interests of Southern Rhodesia and for that reason is doubtful as to the policy of segregation. Neither the agricultural conditions, native habits, nor the transport facilities of the country lend themselves to large-scale native production, nor can it be expected to adopt what is really a plantation policy. It is true that the individual native grower does not necessarily belong to a plantation system, but in reality whether the plantation is run by the Government or by large firms it comes to the same thing. The native does the cultivation; seed, supervision, machinery, and storage have to be supplied and the crop financed up to the point where it gets a European market. This is essentially plantation production as opposed to real farming.

This is no argument against native production of food crops or any other crops the natives choose to grow with the same aid or encouragement as is given to a white farmer, but it is against the deliberate adoption of a policy of subsidizing the native as a producer of crops for export. At the same time it may be that the only way to avoid racial friction is to define the areas of settlement and encourage a peasant proprietor class to grow up towards the ideal of economic independence. That this can be achieved in Rhodesia by agriculture without capital expenditure is very doubtful, and in the long run labor will go where it can earn the most.

The utilization of the indigenous native to a greater extent is one of the pressing problems of the day, and no excuse is needed for the space devoted to it. The country cannot always rely on the northern boy, since the development of the Congo may set the stream flowing north; and, even were it not a condition of white settlement that there should be an adequate supply of unskilled and semi-skilled labor, it is eminently in the interests of the natives themselves that they should acquire the habits of regular work and, as wage earners, become also producers of wealth. The Government of Southern Rhodesia is alive to the necessity of providing a stimulus and a reward for those who become useful citizens and is considering a scheme to enable them to become freeholders of land in suitable areas—a right they possess but which public opinion is averse to their exercising.

EUROPEAN INDUSTRIES: MINING

Southern Rhodesia and the northern Transvaal show evidences of prehistoric colonization on a scale comparing favorably with their present population. It is not without significance that these "ancients," as we call them, were attracted by the mineral wealth; and at a rough estimate they took about twice as much gold out of Rhodesia as has been discovered in the thirty years of British occupation. Besides their abandoned mines, which constitute the largest mining area in the world in actual extent, there are thickly scattered about Rhodesia the ruins of dry-stone masonry of a very substantial kind but unknown origin, remains of terraces and watercourses, and other evidences of a cultivation which must have provided food for a much larger population than is now fed on the country. Controversy still rages as to the origin and age of these ancient remains, some persons asserting that they are simply the work of previous generations of natives (though this does not account for the mines nor for the absence of native traditions concerning the buildings), and others pointing to certain decorative or symbolic features as showing Arabian or Mediterranean origin, while it is generally conceded that the rock mining is similar to that found in India and that trees and plants of Indian origin are frequently seen near such mines and nowhere else.

Although we may begrudge the ancients the large amount of precious metal of which they denuded the country, we must acknowledge that, had they not so successfully prospected, the gold might still be undiscovered in the heart of an inaccessible and uncivilized native territory. It was the report of the old workings that led to the occupation in 1890; and today, if the ancients are nothing else to us, they have at least provided us with an attraction for tourists in the shape of Zimbabwe and other ruins and an unsolved problem of archeology.

Gold to the value of £57,522,000 has been exported from Southern Rhodesia since 1899. The best year was 1916 when nearly £4,000,000 sterling was taken, but the figure now seems stationary at about £3,000,000, placing the country seventh among the gold-producing countries of the world. Practically every mine being worked today was located in the early days and is on the site of old workings. Prospecting has been stagnant until last year when the government tried to revive it by a system of grants, but so far with no results to show.

A geological survey of the country is now completed and should be of the greatest assistance to prospectors. It is certainly hard to believe that the ancients, without the aid of science and in the days when the country was in all probability completely covered with forest and bush, discovered all that Rhodesia contains. No mining authority believes that the reefs are exhausted or that no more reefs will be found. Several minor discoveries recently and notably the recovery of a reef, at an unexpectedly great depth, in a mine that had been closed down have encouraged the hope that further and deeper excavation may be rewarded.

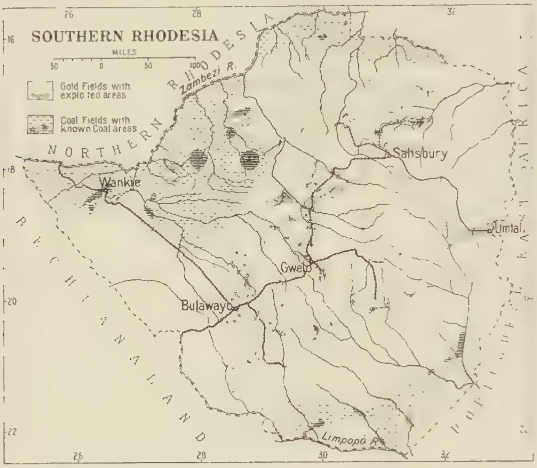

Fig. 3—Gold and coal resources of Southern Rhodesia. Scale of map 1:13,000,000.

Coal, worked only at one place, Wankie, although it is found in many others, accounts for two and a half million and an average annual production of about a quarter of a million. It is a monopoly of the British South Africa Company; and it is not in their interest to permit competition which, moreover, they could easily crush, as they have in Wankie one of the largest and richest coal fields in the world. The cost to consumers is high, not only on account of freight but also of pit-mouth cost, and it is to some extent a tax on industry.

Chrome ore and asbestos are next in importance, and they have been increasing considerably in value. They account respectively for £250,000 and for £600,000 to £700,000. Asbestos, being inexpensively worked, is one of the most profitable mining propositions in Rhodesia and is of recent development.

Copper, of which there is plenty in many parts of the colony, is dwindling for a variety of reasons, and platinum has not yet found its way into the available statistics although "finds" have been reported. Tin has been found in small quantities; and there is at the moment some interest being taken in corundum, which occurs in one district in considerable quantities.

The developments in mining will help to stimulate settlement, for, although a mining population is not, generally speaking, as permanent as a farming community, it has a strong tendency to become permanent in Rhodesia, especially among the smaller workers.

Agriculture

The staples of our agriculture are cattle, maize, tobacco, and latterly cotton. In the western districts with a lower rainfall and a good deal of light soil cattle predominate. There are about two million head in the country, divided pretty evenly between Europeans and natives. Pure-bred stock are on the increase, shorthorns being the favorite. In the last year or two dairying has become a very profitable industry especially in the neighborhood of the two largest towns.

During the war and for two years after, the price of cattle of any kind was high; but for the last five years Southern Rhodesia, like other cattle countries, has been suffering from a severe slump. The distance of her markets coupled with the fact that her southern neighbor, her best customer in the past, is now becoming a serious competitor and is imposing restrictions on the import of Rhodesian slaughter cattle, have combined to depress her prices so severely as to give a definite check to breeding. The depression has, however, had a good effect in convincing men that quality is better than quantity.

Last year the Government concluded an arrangement with the cold storage company that has a monopoly of South African internal trade, whereby, in exchange for the sole right to freeze and export from Southern Rhodesia, the company is to erect the necessary works at a stipulated expense. The agreement was in line with expert opinion that, in the absence of a good market for fresh meat or cattle on the hoof, cold storage was the only possible method of disposing of our beasts. Up to the present the cold storage works have not materialized, but the company has been buying on the hoof for the Johannesburg market and paying a very low price. Interesting experiments in sending live cattle to Italy and England have resulted in good prices and a favorable opinion of our stock, but the problem of cheaper transport has to be solved.

There is another market in the Congo, which has also been partly closed to us by the jealousy of Northern Rhodesia, although she could not supply it from her own European-owned herds. Both the Union and the Congo, however, are practically obliged to come to us, and the traffic is likely to increase when some of the political motives for trying to exclude Southern Rhodesia have ceased. Our cattle are in prime condition at a time when South Africa needs them, and the Congo demands will increase rapidly.

Until lately maize stood alone as the one agricultural product that could be regarded as a staple export. Tobacco had been tried, proved successful, but was killed by the monopoly of a company which dictated prices all over Africa. It could not be profitably shipped to England in competition with American leaf. A preference given to Empire-grown leaf has in the last two years revived this industry, and it is now one of the most profitable in the colony. Bright leaf of very good quality can be grown on a large proportion of the farming soil, and a grade suitable for pipe tobacco over a much larger area. Cotton, too, has been grown for some years, but was not profitable at the prices current until recently; and now it is the subject of government experiment to decide the best soil, method, and seed to ensure a high standard of staple and yield.

Southern Rhodesia's hope in all production is quality, which she has already secured in maize, tobacco, and cotton. If the highest standard can be maintained she will not feel the handicap of her long haul to the coast so severely. It is for this reason that only farmer settlers with capital and brains are likely to do really well; and the native grower, unless heavily subsidized and supervised, might prove a source of weakness. Haphazard methods, of which we have had a good deal in the past, are not going to succeed longer. The government has a fully equipped scientific agricultural staff, a large veterinary staff, and a small but exceedingly efficient bacteriological staff for animal diseases; and with this up-to-date equipment a farmer ought to be able to start on the best lines.

Conclusion

From many aspects this experiment in tropical colonization is of peculiar interest, and the writer is hopeful that the courage which carried Southern Rhodesia through an exceptionally trying period and caused her to choose self-government rather than risk the loss of her identity in the Union of South Africa will stand her in good stead and enable her to take long views and brave decisions in the days that are to come. It is more than probable that this small white community is the nucleus of another self-governing nation within the British Empire and that in time to come its position in the heart of the African continent will give it strategic importance from the racial and economic as well as from the military point of view.

THE WINELAND VOYAGES:

A FEW SUGGESTIONS

Halldór Hermannsson

SINCE no authenticated Nǫrse remains have as yet been found on the American continent[1] we have no way of verifying or controlling the accounts found in the Icelandic sagas of the discovery of America and the attempt at colonization there in the eleventh century. The accounts themselves, however, are of such a character as to leave no doubt that they deal with historical events. Even the discrepancies between the two principal sources, the Saga of Eric the Red and the Tale of the Greenlanders, tend rather to strengthen the conviction of a trustworthy tradition which has taken a slightly different form in different localities. These differences, however, make it more difficult to arrive at plausible conclusions about the course of the voyages and the places mentioned. To those familiar with the saga literature in general there can be no question that the Saga of Eric gives the impression of greater reliability, and in its favor also is the fact that it is the older of the two sources. Therefore, in my opinion, it must be taken as a basis for any treatment of the subject, while certain details found only in the Tale deserve due consideration.

The Story of the Voyages

The main features of the story are as follows: Leif Ericsson on his way from Norway to Greenland by the southern route, that is directly from Norway without touching Iceland, was driven out of his course and finally came upon a land which, on account of the presence of wild grapes, he called Wineland. He continued his voyage northward in the same summer until he reached Greenland. A few years later the Icelander, Thorfinn Karlsefni, started from Greenland on an expedition to Wineland with three ships and with the intention of settling there. He followed Leif's route, going in the opposite direction. After crossing Davis Strait he first sighted a land which he called Helluland, or Flagstone-land, then Markland, or Forest-land; thereafter he sailed along a long, low, and sandy coast which he called Furdustrandir, or Wonderstrands, and finally arrived at a bay which, because of strong currents, he called Straumfiord. There the first winter was spent. Next summer he continued the voyage southward to Hóp, which he seemingly looked upon as a part of Leif's Wineland and where he spent the second winter. The following summer he returned to Straumfiord, spent the third winter there again, and returned to Greenland during the fourth summer.

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[1] Referring to the ruins in Labrador to which a Norse origin has been accredited, Mr. Gathorne-Hardy points "in the most guarded language" to the "possibility" that they have been erected by an Eskimoized Norse people (G. M. Gathorne-Hardy: A Recent Journey to Northern Labrador, *Geogr. Journ.*, Vol. 59, 1922, pp. 153–169).

LEIF'S ROUTE NORTHWARD FROM WINELAND

Since Rafn, in the earlier half of the nineteenth century, tried to identify these names with various localities on the east coast of America, many attempts have been made to find a solution of the problem.[2] No general agreement has yet been arrived at, which is natural considering the material we have to work with. The chief mistake made by most writers on the subject is the attempt to reconstruct Karlsefni's route towards the south, without first investigating the route Leif followed on his way north. The point is fundamental, because the route was established from south to north. It can be taken for certain that Karlsefni had with him as guides some of the men who had been with Leif; but, as they had sailed over the course only once, it must have been difficult for them to keep it, especially as they were now going in the opposite direction.

Let us then first follow Leif on his voyage. He probably lost his way somewhere in the mid-Atlantic and was driven by easterly or northerly winds into the foggy region of the Newfoundland Banks. It would be most natural to believe that he had struck either Newfoundland or Nova Scotia, but in neither of these would he have found grapes; so, following the lead of the Saga, we must assume that his landfall was farther south, somewhere on the coast of New England south of the northern limit of the wild grape, which, I believe, is generally supposed to have been near Passamaquoddy Bay. From there he would naturally follow the coast towards the northeast, probably going into the Bay of Fundy only to find that there was no through passage and so rounding Nova Scotia and Cape Breton until he came to Cape North where the land ends. From there he is not likely to have turned to the southwest to follow the coasts of Prince Edward Island and New Brunswick. From Cape North at sea level he could hardly see Newfoundland even under the most favorable circumstances; the distance is too great, and, besides, Cabot Strait is notorious for dense fog during the summer months.

The most natural thing for him to do, it seems to me, was to take the course due north from the cape. In such case two things might have happened. Either he struck the southwestern portion of Newfoundland near Cape Ray and thence sailed along the west coast of Newfoundland northwards; or he went into the Gulf of St. Lawrence between Newfoundland and the Magdalen Islands and continued his

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[2] See W. H. Babcock: Recent History and Present Status of the Vinland Problem, *Geogr. Rev.*, Vol. 11, 1921, pp. 265–282; and a recent paper by Gustav Holm: Small Additions to the Vinland Problem in consequence of Professor H. P. Steensby's "Norsemen's Route from Greenland to Wineland," *Meddelelser om Grønland*, Vol. 59, 1925, pp. 11–37.

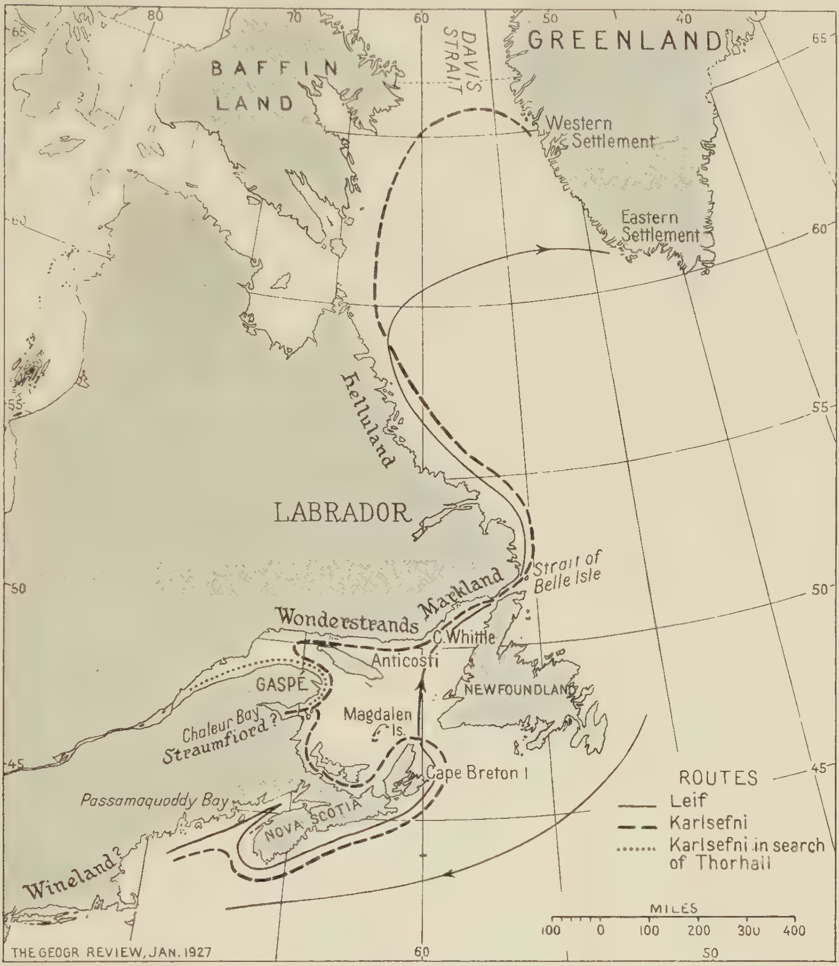

FIG. 1—Sketch map showing the courses of the Wineland Voyages and identification of places mentioned in the sagas (in antique lettering). Scale 1:25,000,000.

voyage until he became aware of the south coast of Labrador, which he then followed eastward. In either case he must have gone through the Strait of Belle Isle. This is of importance because, unless Leif went out through the Strait, Karlsefni is not likely to have passed in. It is so narrow as to look like a bay from the outside, and it took later explorers some time to discover that there was a passage through there. After passing the strait Leif, of course, followed the east coast of Labrador until the time came to cross Davis Strait in order to reach Greenland.

KARLSEFNI'S SOUTHWARD VOYAGE

Having thus traced Leif's probable route, we turn to Karlsefni's voyage from north to south. According to the Saga he crossed Davis Strait from the Western Settlement, or even a little north of it. He then sailed southward along the east coast of Labrador until he reached the Strait of Belle Isle, probably well remembered by the men of Leif's crew. He passed through it and kept to the south coast of Labrador. His ships were heavily loaded with live stock and other things necessary for settlement, hence, as Hovgaard has suggested, his voyage was probably slower than that of Leif, and the season was fast advancing. He saw the land stretching southwestward and probably was tempted to follow it, possibly in the hope of finding winter quarters there instead of sailing out into the gulf. Very likely the guides were uncertain about the route. Anyway he followed the south coast, discovered first a thickly wooded country and thereafter a long, low, and harborless shore. He presumably sailed along this until he came into the estuary of the St. Lawrence and saw the high peninsula of Gaspé on the south side, to which he turned leaving this desolate coast behind. Realizing by this time that he had gone much farther west than Leif and not seeing any particularly attractive place for settlement, he may have turned eastward along the northern shore of Gaspé. Or he may have seen the northwestern point of Anticosti Island and sailed from the Labrador coast towards that and thence to Gaspé, whose bold northern shores would probably be visible under favorable conditions. In either case he must have proceeded along the east coast of Gaspé until the waters of Chaleur Bay opened before him and he saw the inviting landscape around the bay in all its late summer beauty. One can easily imagine that this made a strong appeal to the weary voyagers, so that they decided to settle here or, at least, to spend the winter.

IDENTIFICATION OF STRAUMFIORD

Various things lead to the identification of Chaleur Bay with Straumfiord. The Saga describes Straumfiord thus:

> There was an island at the mouth of the fiord, about which there were strong currents, wherefore they called it Straumey. There were so many birds there that it was scarcely possible to step between the eggs. They sailed in through the fiord and called it Straumfiord and carried their cargoes ashore from the ships and established themselves there. . . . Mountains were there, and it was beautiful to look about. . . . There were great pastures.

Compare this with Cartier's description of Chaleur Bay when he discovered it in September 1534:

> . . . the land toward the south of the said bay is as fair as good land, arable and full of as goodly fields and meadows as we may have seen, and level as a pond; and that toward the north is a high land, with mountains all full of trees of tall growth, of many sorts, and among others are many cedars and firs as goodly as it may be possible to behold for to make masts sufficient to mast ships of three hundred tons or more; in which we did not see a single place void of woods, save in two places of low lands, where were very beautiful meadows and lakes. . . . Their land is more temperate in heat than the land of Spain, and the most goodly that may be possible to see, and as level as a pond. And there is not here any little spot void of woods and made up of sand, which may not be full of wild grain, which has an ear like rye, and the kernel like oats, and peas as thick as if one had sown and cultivated them; gooseberries, white and red, strawberries, raspberries, and red roses, and other herbs of sweet and powerful odor; likewise there are many fair meadows and good herbs, and ponds where there are plenty of salmon.[3]

There is undeniably some similarity between the two descriptions, the Saga, true to its traditions, not entering into so minute details as the French account. Whether, however, there are such strong currents in Chaleur Bay as would warrant its being called Straumfiord, I do not know. Outside, off the mouth of the bay, and especially on Miscou Bank, the currents and tidal currents are irregular, both in rate and direction; the tide rises at Miscou Harbor to five feet, while at the head of the bay, at Campbellton, it is ten feet.[4] The two islands at its mouth, Miscou Island and Shippigan Island, might easily have become one in the tradition; even at the present day they are extremely rich in bird life and in that respect correspond well to the description of Straumey. One also gets the impression from the Saga that Straumfiord was quite large, since Karlsefni and his men devoted the rest of the summer to the exploration of it and of the surrounding country. The objection may be raised that they spent two winters in Straumfiord apparently without coming in contact with the natives. In Cartier's day Chaleur Bay was much frequented by the Indians because of its excellent fisheries. This, of course, may have been different five hundred years earlier.

But what was fine and fair in summer took on a totally different aspect in winter. There were marked contrasts between the seasons in Straumfiord as in Chaleur Bay. Karlsefni and his men, enraptured by the beauty and bounty of the summer, took no thought to provide for the winter. This was very severe: the water froze and the fisheries failed, so that they came near starving. Only improvement in the weather, which made it possible for them to row out to sea, and the coming of spring saved them. All this had caused great disappointment among them. Thorhall the Hunter, who had been an unwilling member of the expedition from the start, complained that they had found no grapes and that he had not got "the best of drinks" which he had been promised before leaving Greenland. This he expressed in two ditties included in the Saga. They are undoubtedly genuine and show conclusively that Straumfiord must be sought outside the northern limits for wild grapes. Thorhall with other malcontents took one of the ships and left for Greenland. Karlsefni also realized that he must seek a better place, so he went southward east of the country with the two remaining ships. If my theory as to Chaleur Bay is correct, that means that he followed the coast and went east of Nova Scotia, which would well agree with the phrase used in the Saga, and thus picked up Leif's tracks again. He sailed until he came to the place which he called Hóp where he found similar conditions to those Leif had discovered in Wineland. But whether Hóp is identical with Leif's landfall is another matter. Anyway, if we accept the story of the grapes as true, this place must have been south of Passamaquoddy Bay. There are many theories as to its location, but into that I shall not enter here. Although Karlsefni was greatly pleased with the land and the climate there, he had to leave next summer because of the hostility of the natives.

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[3] J. P. Baxter: A Memoir of Jacques Cartier, New York, 1906, pp. 102 and 106–107.

[4] St. Lawrence Pilot, 5th edit., *U. S. Hydrogr. Office Publ. No. 100*, Washington, 1925, pp. 49, 211, and 213.

Markland and Wonderstrands

I have dwelt so long upon Straumfiord because its identification with Chaleur Bay is my own suggestion, while part of Karlsefni's route as outlined above has previously been suggested by Professor Steensby in his book "The Norsemen's Route from Greenland to Wineland,"[5] although his premises are somewhat different from mine. As to Helluland there seems to be a general agreement among writers on the subject that its description in the Saga fits the east coast of Labrador. But regarding Markland and Wonderstrands there is a great difference of opinion. I am inclined to agree with Steensby that these two are to be sought on the south coast of Labrador.

The Saga says that Markland had a large forest and many wild beasts. An island lay southeast from it, and upon that they found a bear; hence they called it Bear Island. This could well be the northern point of Newfoundland, which they almost inevitably would have taken for an island if they went through the strait. In such case Markland would be the south coast of Labrador not very far west of the Strait of Belle Isle. The desolation of that coastal region has been vividly expressed by Cartier's characterization of it as the land God allotted to Cain. In regard to which a modern writer remarks: "A short journey up any of the rivers which reach the coast of southeastern Labrador, however, will take the explorer into a densely wooded country which has no resemblance to the barren coast line and will convince him of the injustice of this description."[6] While it is not likely that our explorers at that stage of their voyage went very far inland to investigate the country, they are almost sure to have made some survey of the land beyond the nearest shore. So the objections raised against locating Markland here do not seem to have disproved our theory. The Tale has a slightly different description of Markland: "This was a level wooded land, and there were broad stretches of white sand where they went, and the slope down to the sea was not very abrupt." Here evidently is a peculiar feature which made an impression upon the voyagers and which the Saga has forgotten but which the Tale has preserved. This supports our theory. Just inside of the Strait of Belle Isle is Blanc Sablon, so named by Cartier "owing to the whiteness of its sandy shores when seen from the deck of a ship on a sunny day."[7]

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[5] H. P. Steensby: The Norsemen's Route from Greenland to Wineland, Copenhagen, 1918.

After leaving Markland Karlsefni and his men, the Saga says, "sailed southward along the land for a long time and came to a cape; the land lay upon the starboard; there were long strands and sandy banks there. They rowed to the land and found upon the cape there the keel of a ship, and they called it Kialarnes (Keelness); they also gave a name to the strands, and called them Furdustrandir (Wonderstrands), because they were so long to sail by." These strands have been a particular stumblingblock to commentators, because no feature on the east coast of America facing the open sea answers such a description. Beginning with Rafn many writers have identified Wonderstrands with Cape Cod. But that is out of the question: they cannot be so far south, and it would not have taken the voyagers long to sail by that short strip of coast. Professor Steensby has pointed out a place that corresponds to the description. He writes: "I do not hesitate to maintain that it would be impossible to find a stretch of coast on America's northeast coast which better suits the account of the Saga than does the coast of Labrador, especially the stretch to the west of Cape Whittle."[8] And I agree with him, although I find that the rest of his theory as to the further progress of the voyage is absolutely untenable. This coast is little known, but the few available descriptions are in harmony with the characterization, from Cartier who speaks of the coast "wholly ranged with sands without having there any appearance of a harbor" to C. W. Townsend[9] who follows the succession of beaches on the Côte Nord and points out as a distinguishing feature of this coast "its long reaches of sandy shores." Sand bars characterize the mouths of most of the numerous rivers, and, according to the St. Lawrence Pilot (p. 347), "the appearance of this coast from the distance of about 12 miles is so little diversified that it is almost impossible to distinguish one part of it from another."

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[6] E. M. Kindle: Notes on the Forests of Southeastern Labrador, *Geogr. Rev*, Vol. 12, 1922, pp. 57–71; reference on p. 57.

[7] Baxter, *op. cit.*, p. 83.

[8] Steensby, *op. cit.*, p. 47.

[9] C. W. Townsend: A Labrador Spring, Boston, 1910.

When Thorhall the Hunter left Straumfiord he pretended that he was going to seek Wineland to the northward beyond Wonderstrands. Next summer upon his return from Hóp to Straumfiord Karlsefni set out with one ship in search of Thorhall. "They sailed to the northward around Keelness, and then bore to the westward, having land on the larboard. The country there was wooded wilderness." We have probably to allow for some confusion here concerning Keelness, since that place according to the Saga was on or near the Wonderstrands. But if Straumfiord is Chaleur Bay, Karlsefni on this trip seemingly sailed around the Gaspé peninsula and followed the north coast of it westward into the estuary or river of St. Lawrence, and it was here, at the mouth of one of the small rivers, that Thorvald Ericsson was killed by the uniped. We are not likely now to put much credence in the existence of such fabulous beings. But as a curiosity I may mention that Donnacona told Cartier at Stadaconé that he had visited a country "where the people have only one leg."[10] Could there possibly be any connection between the two stories?

What I have set forth here is merely a few suggestions which seem quite plausible to me. What others think of them remains to be seen. But so much has been written and so many theories advanced with the aid of books and maps, on this subject, that it is very desirable that some one should take the matter up in a more practical way and actually investigate these regions to see whether some light cannot be thrown on this interesting problem of historical geography.

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[10] Baxter, *op. cit.*, p. 199.

THE PHYSIOGRAPHIC INTERPRETATION OF THE NAUTICAL CHART

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ON September 1, 1923, southeastern Japan was devastated by a great earthquake which, although probably not so severe as others which have occurred in that region in historic times, was unprecedented as to the number of lives lost and the magnitude of the property damage.

This disaster momentarily focused public interest on the necessity of seeking in every possible way to minimize the economic effects of these seismic disturbances. It also gave added impetus to the more serious and sustained interest of geophysicists, already actively seeking the solution of the same problem.

An important element in this problem consists in determining the character of the earth movements accompanying the disturbance. Thus, the Federal government has recently completed an extensive triangulation in California to measure the change produced by the San Francisco earthquake in the positions of a large number of pre-existing triangulation stations on either side of the fault line.

In other cases the center of the disturbance is located beneath the bed of the ocean. The recent Japanese earthquake is an example of this group. Shortly after that disaster soundings were taken in the Bay of Sagami which led the Imperial Marine Observatory to conclude that "if the materials which had been used for tracing the chart of Sagami Bay did not comprise large errors" there had been a maximum subsidence of 259 fathoms and a maximum upheaval of 135 fathoms.[1]

The excerpt quoted is a significant recognition of a limitation on basic data not always taken into account. Nautical charts are in constant use not only in these seismological studies but also for research in a wide range of geological investigations, and proper use for such purposes demands a critical appraisal of the contained data and that the deductions from them be limited to such as their probable accuracy warrants.

The critical evaluation of a chart demands an intimate and detailed knowledge of all the factors involved in its production. The present discussion will be limited in its application to the charts produced by the Coast and Geodetic Survey, concerning which the writer can speak with the necessary measure of authority. It is believed, however, that the standards of accuracy of the Coast and Geodetic Survey equal those of the best contemporaneous practice of the charting agencies of other nations, and that the following statement may be accepted as indicating, in a general way, the limitations to which all charts are subject.

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[1] K. Suda: On the Great Japanese Earthquake of September 1st, 1923: *Memoirs Imp. Marine Observatory, Kobe, Japan*, Vol. 1, No. 4, 1924, pp. 1–6, 137–239, and 1–49; reference on p. 168.

Utilitarian Purpose of the Chart

The purpose of the nautical chart is primarily utilitarian. It is the product of the obligation incumbent upon each maritime nation to furnish shipping the information necessary to safe navigation, to which every other purpose is subordinated. For example, in the field, surveys must be made first of the shoal areas which may contain dangerous obstructions rather than of the deeps, whose exploration admittedly would produce information of great scientific value but which are of minor interest to the mariner. Similarly, in the drafting room, the Mercator projection is used as the framework for the chart because that projection is particularly adapted to the mariner's needs, in spite of the fact that for general purposes it is less suitable than others available.

The task of surveying the waters of the earth is such a stupendous one that the combined effort of all participating nations has scarcely made a beginning of its accomplishment. Necessarily most surveys have been confined to the proximity of the land. With increasing departure from the shore and deepening of the water, the sounding lines become progressively more widely spaced and, when beyond sight of land, subject to uncertainties that will be discussed in detail later.

To illustrate with a single example: in a resurvey of the Atlantic coast now in progress by the Coast and Geodetic Survey, the section extending from abreast Chesapeake Bay entrance to the Straits of Florida is one in which moderate depths extend far offshore and where no great and abrupt inequalities in depth need be expected. This area is being covered by a primary system of sounding lines for which the specifications in general prescribe a spacing of sounding lines approximately as follows:

(a) From the shore to the 10-fathom curve, lines spaced ¼ mile apart, crossed by lines at right angles spaced 2 miles apart.

(b) From the 10- to the 15-fathom curve, lines spaced ½ mile apart.

(c) From the 15- to the 25-fathom curve, lines spaced 2 miles apart.

(d) From the 25- to the 100-fathom curve, lines spaced 4 miles apart.

On these lines the soundings are taken as rapidly as the depths permit: in less than 10 fathoms about 35 to 60 to the mile; between 10 and 20 fathoms, 20 to 35 to the mile; 20 to 50 fathoms, 5 to 10 to the mile; 50 to 100 fathoms, 1 to 5 to the mile. Any indication of shoaling revealed by these primary systems of lines is further examined later. Thus an area five miles square near the five-fathom curve would contain about 5000 soundings, while the same area at the 100-fathom curve would not contain more than 15.[2]

The standards of accuracy prevailing today were impossible of attainment a century ago when the Survey began its task. The art of hydrographic surveying has developed just as have other arts and sciences during that period. Take the case of improved equipment alone: the sailing ship has given place to the steamer, the hand-manipulated hempen sounding line to the steel piano wire carried on a motor driven reel, and both to the supersensitiveness of radio acoustics. The radio time signal is now broadcast daily, insuring the accuracy of chronometers to a small fraction of a second and thus making it possible to fix astronomic positions with a certainty previously undreamed of.

DEPTH MEASUREMENT

A hydrographic survey consists of a collection of soundings, each of which involves two separate and distinct operations: (1) the measurement of the depth, and (2) the determination of the point at which the measurement was made.

The immemorial method of sounding in deep water has been to bring the vessel to a complete stop and lower a weight to the bottom, recording the length of line unreeled in the process. Possible errors in the measurements may result from the lift of the waves, the overrunning of the wire after the lead has reached the bottom, and, most important of all, the drift of the vessel from its position directly above the descending lead, which must be lowered at moderate speed in order to be under control at all times. The effect of these errors is to give recorded depths greater than true depths. The percentage of error usually will be in inverse ratio to the depth, particularly if the latter be great and approximately known in advance of the sounding. A probable error of about two per cent in depths of 100 fathoms, and of one per cent in depths of 1000 is a reasonable assumption for carefully executed modern work of this character. The errors in soundings taken many years ago will be somewhat greater than those given above: on the average, one may say, they probably were about double.

To eliminate the disadvantage of this laborious and costly method various devices have been introduced for sounding without reducing the ship's speed. Thus the depth is recorded by the compression of an imprisoned column of air lowered to the bottom. These pressure tubes have long been in extensive use by the merchant marine, but the Coast and Geodetic Survey has considered them too inaccurate and untrustworthy to meet the more exacting requirements of hydrographic surveying. Recently, however, the Survey has perfected a tube free from the defects of the commercial types and permitting an accuracy little inferior, if at all, to the sounding lead. It is now in constant use in depths less than a hundred fathoms. Special precautions are taken in use: each tube is calibrated separately for each day it is used, and for each cast two tubes are used. Occasional vertical casts are taken to compare direct and indirect measurements.

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[2] In order to preserve legibility only a few of these soundings are shown on the published chart, but of course all are used for drawing the depth curves.

The writer recently has made further study of this method. Among other things he compared the simultaneous depth measures obtained from the two tubes used for each sounding. Each measure had been corrected separately for temperature and barometric pressure. The average difference between the shoaler and the deeper soundings of each pair on one survey was 1.7 per cent of the depth in depths ranging from 13 to 90 fathoms, and on the other 1.1 per cent of the depth in depths ranging from 13 to 70 fathoms. The mean of the two simultaneous measures, which is used as the sounding, would therefore appear in general to have a possible error of less than one per cent—this conclusion being based on the assumption that the calibration to which each tube is subjected on each day it is used takes satisfactory account of the systematic errors.

Echo sounding is the latest method of measuring depths in the deeper waters of the ocean.[3] This method is an adaptation of devices developed during the war for the detection of submarines. Very briefly, it consists in the accurate measurement of the time required for a sound wave to travel from the ship to the bottom and be reflected back again. The depth can then be deduced from the known velocity of sound in sea water, corrected for variations from the standard velocity dependent on conditions of temperature, density, and salinity.

The method is too newly developed to justify any discussion here of its present accuracy. It is mentioned rather because of the promise it holds out for the near future. The rapidity with which soundings can be taken will permit of examining interesting submerged areas with a minuteness not to be thought of under any previous method, and we can confidently hope that future developments will enable us to produce a contour map of a rugged sea bottom with an accuracy superior to that with which we map the topography of a mountainous region today.

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[3] H. C. Hayes: The Application of Acoustics to Submarine Surveying, *Geogr. Rev.*, *Special Suppl.*, Vol. 14, 1924, pp. 681–694.

Determination of Position

A record of depth is of no value unless we know the position at which it is measured. When the sounding is taken within sight of land, the position is determined by measuring the angles between known points on shore. As a rule we can assume that a satisfactory degree of accuracy is obtained. When the land is invisible, the determination of position is much more complicated and difficult. The methods ordinarily used in navigation and in the hydrographic work of the Survey until the last few years involve astronomic determinations or dead reckoning or a combination of both.

In the dead-reckoning method the vessel either starts or stops at a known point. She will run for hours or days without a "fix," the approximate position at any moment being derived by plotting, forward or backward from the known position, the course steered and the distance logged, corrected by the mariner's guess as to the effect upon his vessel of wind, waves, and currents. As all these effects are uncertain and variable, it is obvious that before many hours a small vessel such as is used for surveying, and particularly the small sailing ships of an earlier day, may be hopelessly "at sea." Where the vessel starts at one known point and stops at another, the intermediate run will be adjusted between the two; but such an adjustment is still subject to uncertainties. This method, therefore, has been used by the Coast Survey only in default of a better.

Positions determined by astronomic observation are by no means absolute. They are subject to uncertainties resulting from variations in the chronometer error or in refraction or from indefiniteness of horizon that cannot be taken account of in the computations. The writer has known carefully observed simultaneous altitudes of two stars on opposite sides of the zenith, taken under conditions that seemed normal to the observer, to result in positions five miles apart. Even now, with the chronometer error eliminated by the radio time signals, the careful navigator usually will assume a possible error of not less than two miles; in other words, that his vessel may be anywhere within a circle of two miles radius of which the computed position is the center.

Combinations of these methods controlled the offshore hydrography executed by the Coast Survey before 1914. In that year was begun a complete resurvey of the Atlantic continental shelf, for which much more accurate methods were developed. The hydrography, beyond the limit of visibility of shore objects, is now controlled by rows of buoys planted section by section over the area to be sounded. Elaborate methods are used in fixing the positions of these buoys with the result that the probable error in location is about fifteen meters to the mile. These unusually precise results apply only to work executed during and after 1924; in the previous decade the method, while much more precise than any previously used, was still in the developmental stage.

Transmission of sound through sea water, whose application to the measurement of depth has already been noted, has also been applied to the determination of position. Briefly, a submerged bomb is fired from the ship, the instant of firing being recorded on a chronograph aboard the vessel. The sound wave, on reaching the shore, is picked up by a hydrophone. This operates a relay at the shore station which sends a radio signal back to the ship, where it is recorded on the same chronograph. All operations are automatic, and all transmissions are instantaneous except the sound from ship to shore; therefore the elapsed time on the chronograph between the sending and receipt of the signal measures the time required for the sound to reach the shore and consequently the distance. Three shore stations are used, giving the ship's distance from three known points and hence its position with a check. The method must still be regarded as in the developmental stage. Certain fundamental problems require further study, and their solution will undoubtedly result in greater accuracy. Tests indicate that at present the method is slightly inferior to that of measuring the angles between visible objects but superior to the buoy-control method.

Adjustments and Corrections

When the data accumulated by the surveying parties reach the Washington office of the Survey they are scrutinized to reduce inaccuracies. Such a scrutiny was particularly necessary to the work done before 1914. Data were first plotted, making allowance for all factors tending to produce differences between the true and the assumed positions. Where a portion of the work began and ended at known positions, the closing error was distributed throughout the run on the basis of the conditions prevailing while the work was in progress. Frequently the major system of parallel sounding lines was crossed by a second widely spaced system at right angles to the first. Depth contours were drawn and studied, and any parts anomalous to the known physiographic relief were subjected to further scrutiny to eliminate or reduce the anomalies. New work received was compared with all preëxisting data applicable to the same locality. This scrutiny, in modified form, is applied to present-day results, in spite of recent progress in insuring the accuracy of the field work.

In short, the cartographer spreads before him all pertinent data and by careful study seeks to harmonize every part. There is, however, a clearly defined limit beyond which he does not go. He is not permitted to make an "office survey," that is arbitrarily to change the field data to conform to his own individual notion of what is correct.

A factor which becomes noteworthy when our purpose is to study the configuration of a limited area of the ocean floor is that the relation between adjacent charted soundings is not necessarily a constant one. And where, as is frequently the case, the total of available data applicable to an area represents a piecemeal accumulation over a period of years, where the work was performed by sailing ships which zigzagged back and forth on erratic courses, the relationships may become so complex as to defy precise analysis. The results may fill the needs of the mariner and yet be too uncertain to justify use by the scientist for the deduction of conclusions regarding local physiographic forms.

The errors with which we are primarily concerned are the residuals remaining after the office adjustment has been completed. No specific rule for appraising their magnitude can be laid down, since it depends on the data and layout of each individual project and on the conditions under which the work was done.

Probable Errors

Some indication of the probable errors of data appearing on the charts pertaining to areas at a considerable distance from the land can be obtained by comparing the position of a characteristic depth curve, as determined by the recent relatively precise survey, with the position as charted before the application of the modern work. Figure 1 affords such a comparison. In the figure all soundings are in fathoms, and in each case the curve drawn as a solid line was determined by the recent survey, while the broken line is the same curve as previously charted.

The recent surveys were all made since 1916. The earlier positions rested on a meager accumulation of isolated sounding lines run as occasional opportunity offered during a long period of years. The 100-fathom curve south of Cape Hatteras was located largely as an incident to Gulf Stream investigations, where accuracy of position was in large measure subordinated to other objectives.

It is not surprising, therefore, to find these early contours misplaced five miles or more in some localities. Rather, it is gratifying to see how well the sequence of adjustments has reduced errors. Some of the closing errors of the dead-reckoning work were much larger, even when supplemented by astronomic observations. In the extreme case that has come to the writer's attention the vessel, on making a landfall after some days spent in the Gulf Stream under conditions such that no astronomic fixes could be obtained, found its reckoning to be sixty miles in error.

The conditions under which the early work on the South Atlantic coast was executed were probably as adverse as any in the Coast Survey work. Misplacements of the depth curves in excess of those

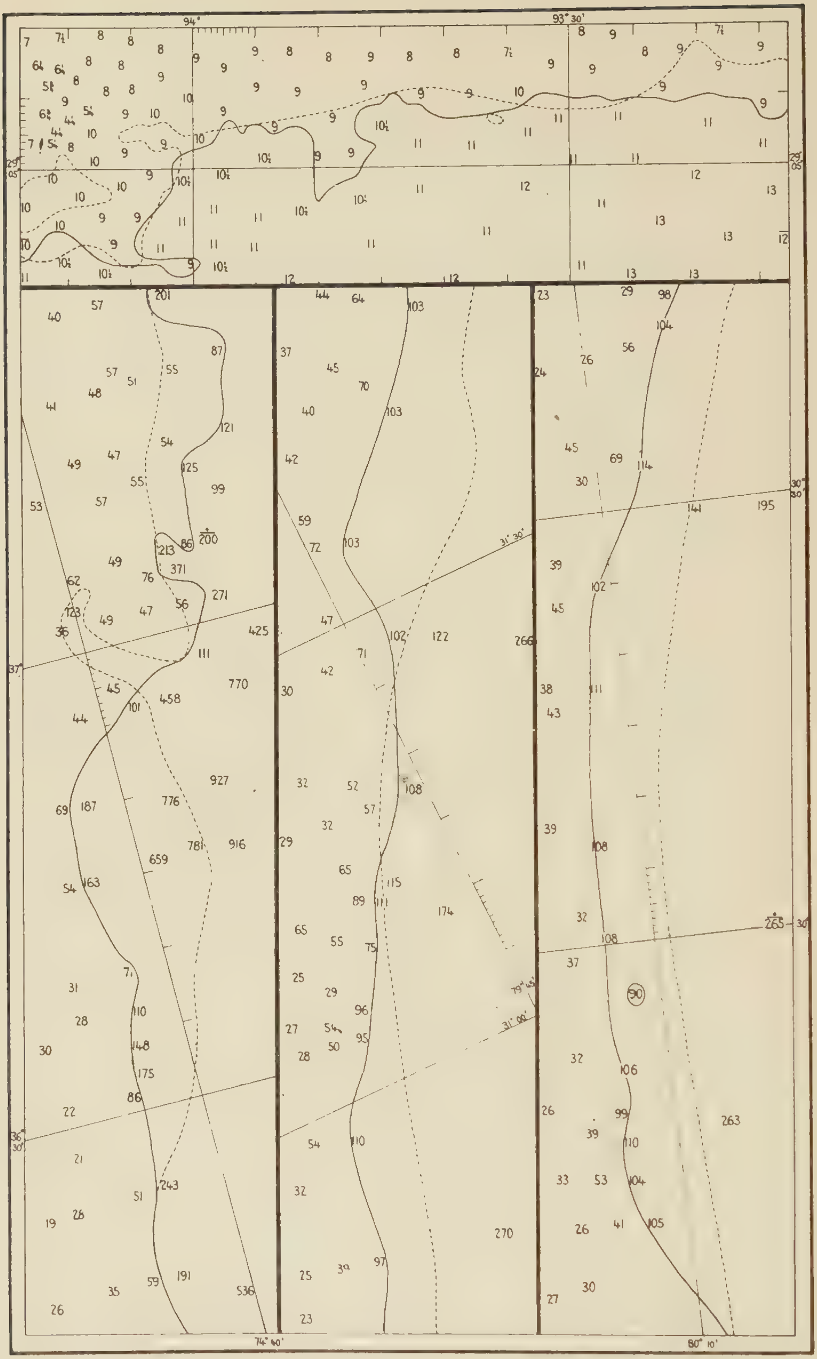

FIG. 1—Characteristic depth curves as determined by recent (solid line) and early (broken line) surveys along the Atlantic coast. Depths in fathoms.

The upper section shows the 10-fathom curve about 35 miles off Sabine Pass, Tex. The lower left-hand section shows the 100-fathom curve abreast Chesapeake Bay entrance, about 65 miles offshore: the middle and right-hand sections the 100-fathom curve from abreast the mouth of the Savannah River to a little south of St. Augustine, Fla., about 70 miles offshore on the average.

shown in the illustration need not be expected along any part of our Atlantic coast with the possible exception of the Gulf of Maine.

Another fruitful source of difficulty results from the charting of reports received from mariners, hundreds of which come to the Coast and Geodetic Survey every year. Many of these reports, although undoubtedly made in good faith, prove upon investigation to have no basis whatever in fact. But all chart-making agencies are guided by the principle that the mariner should be given the benefit of every doubt; and in cases where the information, if correct, would be of value it is charted until such time as an investigation can be made. Sometimes, but by no means invariably, it is qualified by the designation P. D. or E. D. (position doubtful or existence doubtful). As years may elapse before an opportunity for investigation arrives, these data, once charted, are prone to remain on the charts indefinitely. In the acceptance or rejection of information of this character the Coast and Geodetic Survey probably exercises a more exacting discrimination than most of the chart-making agencies of the world. Even so our charts contain hundreds of soundings which, though they cannot harm and may assist the mariner, should be regarded with suspicion by the scientist seeking exact data.

Countless instances might be cited of apparently authentic reports which subsequent investigation has proved to be wholly erroneous. A few months ago a battleship of a certain nation reported having obtained soundings of 13 and 14 fathoms off the California coast at a locality just outside the path of coastwise shipping where the charts showed 500 to 600 fathoms. This report was considered of such importance and of such unquestioned authenticity that it was immediately charted and broadcast to every port of the United States and to foreign countries. A Coast Survey vessel was ordered to make an immediate investigation of the spot. A detailed survey found not the slightest evidence to substantiate the report.

THE PSYCHOLOGICAL FACTOR

A tragic event on the Pacific coast a few years ago illustrates how mistakes of this kind may occur. A large coastwise passenger ship was wrecked with the loss of the vessel and a number of lives. From the subsequent investigation it appeared that the vessel was proceeding in a dense fog by the method commonly practiced under such conditions of relying on the lead to keep in deep water. She could have reached the place where she stranded only by crossing a considerable expanse of shoal water. Yet the officer at the sounding machine at the very moment of striking reported, as he had been reporting for some time previously, no bottom at 100 fathoms. The most probable explanation seems to be that the sounder, believing the vessel to be in deep water, allowed the lead to strike the bottom before he put his hand on the sounding wire to detect the impact signal and that the ship's speed was such as to unreel the wire at about sounding speed, so that to all appearances the lead continued to descend until checked by the machine.

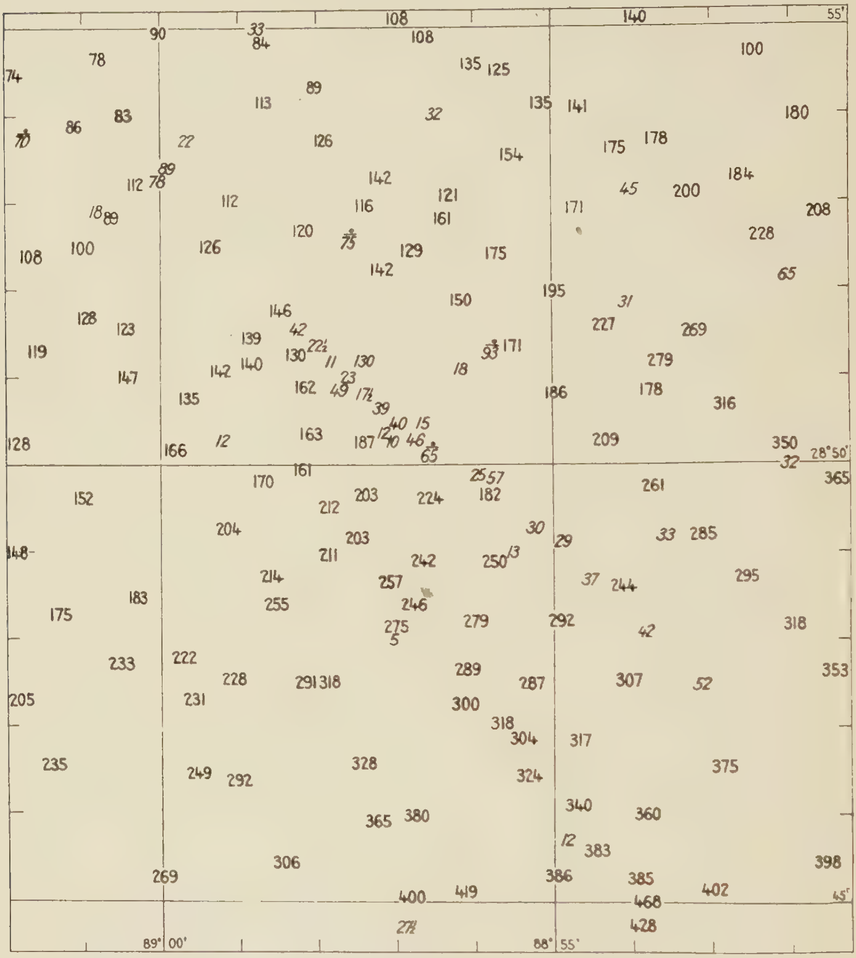

FIG. 2—Reported shoals off entrance to Mississippi River. Oblique figures show reported depths; vertical figures, depths found when searching for the shoals. All depths in fathoms.

A series of parallel lines trending in a northwest-southeast direction, which can be drawn through the reported soundings, represent the tracks of the reporting vessels. In this way the soundings of each report can be segregated from its neighbors.

Thus there is an element of psychology involved in our problem of physiography. One other instance in which the psychological factor affords a possible explanation will be given. This example, the most interesting of its kind that has ever come to the writer's attention, is illustrated in Figure 2. Some time subsequent to 1900 the Survey began receiving reports of shoal areas from 10 to 17 miles southeastward from the South Pass of the Mississippi River, directly in the track of the large ocean vessels bound to or from the river by way of the western end of the Florida Keys. Those reports were received in considerable numbers over a period of several years and indicated shoals several miles in extent. They were most convincing in character; discolored water would be noted, a series of soundings at short intervals would show shoal water, and the lead would bring up samples of the bottom.

On four different occasions a Survey vessel was sent to investigate the locality. In each case no trace of the reported shoals could be found, but instead the new soundings confirmed the depths already charted. Not only were hundreds of soundings taken in these examinations, but in addition the survey ship steamed many miles back and forth across the area towing a submarine sentry which would have given instant notice had it encountered a shoal. Some of these reports are shown in Figure 2 by the oblique figures, while the vertical figures show the depths found by the surveys.

One is reluctant to doubt such circumstantial evidence, yet the evidence of the surveys is even more convincing. Each reader is at liberty to deduce his own explanation. It is possible to justify both reports and surveys by assuming a sequence of volcanic or seismic disturbances; Bogoslof Island at once suggests itself as a precedent. Two objections, however, can be urged in opposition to this explanation: the remoteness of this spot from any region of known volcanic activity and the improbability that such disturbances could have occurred here without furnishing other confirmatory evidence. The psychological explanation has already been mentioned.

Physiographic Interpretations from the Chart

Space does not permit an extended discussion of doubtful conclusions reached by scientists as a result of a too confiding use of these data. A single example will be mentioned, because it so beautifully illustrates the point this paper seeks to make.

One of the most interesting physiographic features of our continental shelves is the submarine valley of the Hudson River. As a result of various scientific studies it has been visualized for us in terms of a grandeur that dwarfs anything we can see today. Deep narrow gorges with vertical walls and waterfalls of great height have been ascribed to it. While the more vivid descriptions have been intended to appeal to the popular imagination, they have adhered with reasonable fidelity to the more soberly stated deductions of various geologists, merely adding the touches of color necessary to give animation to the picture.

Most of these pictures have as their basis Spencer's studies of the valley. Those studies were based primarily on Coast Survey data, but with these data he arbitrarily combined information derived from other sources.

The aggregate of the soundings taken by the Coast Survey in this locality and used in the studies of Spencer and others were obtained at intervals during eleven different years from 1842 to 1905 and in some cases by two or more parties operating independently during the same year. In no case of soundings on any one line, whose relative positions with respect to each other would be approximately correct, were the soundings taken sufficiently close together to indicate inordinately steep slopes. In so far as deductions of such slopes were based on Coast Survey data they were derived from the juxtaposition of soundings whose relative positions were subject to the same uncertainties as their absolute ones.

Spencer's most striking deductions, however, resulted from his interpolation of extraneous information into the Coast Survey data. As he tells the story:

> But on the British charts I made a most astounding find of three soundings of 459, 801 and 229 fathoms. The position of the 459 and of the 801 soundings of the British chart so closely coincided with those of the Coast Survey chart (Coast Survey Chart No. 8 B. A. Chart No. 2480) at 213 and 345 fathom points that they could not have been represented on the same charts. Thus the British chart showed no barrier to the canyon and very greatly increased the known depth of the narrow gorge, further defined by the 229-fathom point. The extraordinary depth would have been startling had it not been anticipated in all of my long series of analyses of submarine valleys. Both series of soundings were correct, the deeper ones having been made by Lt. Com. Z. L. Tanner (Hydrographic Notice to Mariners, No. 56, 1883) in 1883 in the Fish Commission steamer Albatross. The older soundings had been retained on the Coast Survey charts.[4]

It need not be doubted that Tanner obtained the depths reported, thus suggesting the probability that the trough continued to deep water beyond the edge of the shelf. But the locations both of his soundings and of those of the Coast Survey to which they were related were far too uncertain to justify the derivation of a "precipitous" slope connecting the two.

The Coast Survey would not assert that Spencer's deductions were incorrect. It would merely point out the very great uncertainty to which they were subject. Assume three miles as reasonably possible errors for each of the soundings on which Spencer's conclusions depend. Then, considering only factors inherent in the survey, each sounding might belong anywhere within a circle drawn from the assumed position as a center, with a radius equal to the possible error. Then, at one extreme, the 801- and 345-fathom soundings might have been over six miles apart, giving a slope of about four degrees. But since these circles overlap we have not precluded the possibility that the soundings actually were taken at the positions assumed and that the precipitous slope actually exists. Therefore before any satisfactory conclusion could be reached it would be necessary to obtain additional soundings or to take account of known factors foreign to the survey: for example, the geologic formation or the angle of repose of the material of which the exposed surface is composed.

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[4] J. W. Spencer: The Submarine Great Canyon of the Hudson River, *Amer. Journ. of Sci.*, Ser. 4, Vol. 19, 1905, pp. 1–15; reference on p. 5.

THE BOUNDARIES OF THE NEJD

A NOTE ON SPECIAL CONDITIONS

AN international boundary is not always and everywhere a definite line to challenge the wayfarer. Sometimes it is in fact not a line at all but a zone, as in the region of northern Norway and Sweden, where a special convention accommodates the political geography to the physical and cultural conditions of the migratory Lapps.[1] Some of the treaties following the World War have given boundaries special qualities or functions as if they were an organ of international life and not a mere lineament. These features are a response to the needs of various rather primitive societies, specifically pastoral societies, to whom boundary restrictions might be not only vexatious but ruinous.

Recognition of Pastoral Necessities

In the Treaty of Kars signed October 13, 1921, between Turkey on the one hand and the Soviet republics of Armenia, Azerbaijan, and Georgia on the other, there is an agreement "to permit the rural population along the frontier to use their customary pastures across the frontier, permitting them to pass the frontier with their flocks in accordance with frontier regulations to be determined upon by a mixed commission." The final clause of the Angora Accord between France and Turkey (Oct. 20, 1921) provides that "the sedentary or seminomadic inhabitants enjoying pasturage or holding property on either side of the fixed line shall continue to exercise their rights as in the past": for the necessities of their exploitation they are to move freely acrosss the boundary without impost or tax. In the Angora Convention of May 30, 1926, between the same powers, this privilege is specifically applied to the inhabitants of a zone five kilometers wide on either side of the boundary. Similarly in the Treaty of Angora, June 5, 1926, between Great Britain, 'Iraq, and Turkey relative to the frontier north of Mosul, there are provisions for the maintenance of broad neighborly relations on the frontier as well as the prevention of unauthorized movements across it.

Italy and Egypt, by the terms of the Italo-Egyptian Accord (Dec. 6, 1925) respecting the boundary between Libya and Egypt, regulate nomadic affairs, provide for the use of wells on or near the frontier, and agree upon the terms of facilitation of caravans engaged in ordinary commercial transport. In the protocol of January 10, 1924, signed by representatives of the United Kingdom and France, respecting the boundary between French Equatorial Africa and the Anglo-Egyptian Sudan (Treaty Series No. 28, 1924) there is a provision that the Wadi Howa is to remain "common to the tribes living on either bank and each tribe will retain such rights to dig wells, cultivate, and graze within the limits of the valley as they have hitherto enjoyed." One of the general clauses of this agreement states that "where the frontier follows a wadi, cuts a lake or rahad or changes its direction at either of such, the watering rights existing therein will be preserved by the inhabitants on either side."

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[1] K. B. Wiklund: The Lapps in Sweden, *Geogr. Rev.*, Vol. 13, 1923, pp. 223–242.

Never before have international agreements so clearly recognized the geographical basis of a grazing society. Not only is there impact between rival grazing groups, there is also the pressure of the raider upon the settled communities in the river valley below the grassy steppes or elevated plateau where the nomad ranges free. On the nomad, Toynbee has this interpretive paragraph:

> His perpetual motion is not a symptom of waywardness and perversity. It is as scientific as the agriculturist's rotation of crops . . . Both are perpetually shifting the scene of their activities in order not to exhaust a particular parcel of ground . . . The nomad, ranging widely in order to convert grasses into human food through chemical transformations in the bodies of tame animals, regards the agriculturist as a stick-in-the-mud. The agriculturist, raising edible seeds and roots in sufficient quantities out of a much smaller area of land, regards the nomad as a vagabond.
>
> There would be nothing more in this than the commonplace mutual contempt of different trades, if the frontiers between nomad's land and peasant's land were stable. On his own ground, each of them is following that mode of life which the experience of generations has shown to be economically the most productive . . . The traditional bitterness between peasant and nomad arises from a physical cause for which neither is to blame. Their respective environments and the frontiers between them are subject to periodic change . . . Yet while the intrusive nomad has been stigmatised as an ogre, the intrusive peasant has either escaped observation or has been commended as an apostle of civilisation. The reasons for this partiality are clear. One is that the nomad's tactics are more dramatic than the peasant's and make a correspondingly greater impression on the imagination. The other is that history is written for and by the sedentary populations, which are much the most numerous and sophisticated portion of mankind, while the nomad usually suffers and pines away and disappears without telling his tale. Yet, if he did put it on record, he might paint us as monsters.[2]

BOUNDARY AGREEMENTS OF THE NEJD

When the governments of 'Iraq and the Nejd made their first boundary agreement in May, 1922, the Mohammerah Agreement, an article of the treaty recognized the right of any tribe belonging to one country to settle in the other country upon payment of a grazing fee. But it was necessary to go further than this on account of the

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[2] A. J. Toynbee: The Western Question in Greece and Turkey, London, 1922, pp. 339–341.

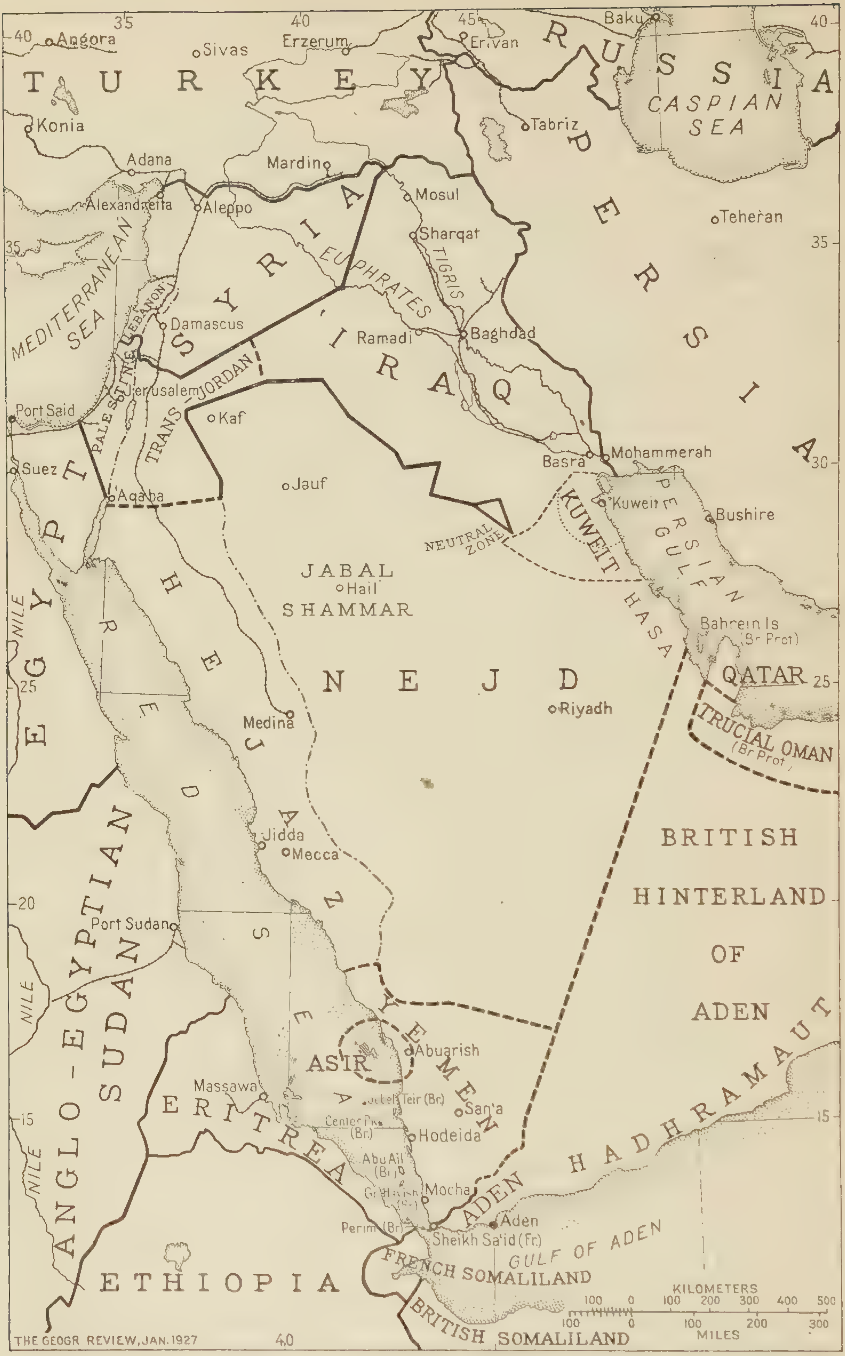

FIG. 1—Map showing the boundaries of the Nejd and adjacent countries. Scale, 1:19,500,000. The northern boundaries of the Nejd are drawn in accord with Figure 2, otherwise the map follows that of Colonel Lawrence Martin in *Foreign Affairs*, July, 1926, p. 680. The heavy lines show international boundaries, solid where the line is determined, broken where undetermined. The dot-and-dash lines show internal boundaries.

supreme importance of desert watering places. Articles 2 and 3 of the protocol appended to the Mohammerah Agreement read as follows:

> Article 2. Whereas many of the wells fall within the 'Iraq boundaries and the Najd side is deprived of them, the 'Iraq Government pledges itself not to interfere with those Najd tribes living in the vicinity of the border should it be necessary for them to resort to the neighboring 'Iraq wells for water, provided that these wells are nearer to them than those within the Najd boundaries.
>
> Article 3. The two Governments mutually agree not to use the watering places and wells situated in the vicinity of the border for any military purpose, such as building forts on them, and not to concentrate troops in their vicinity.

It was soon found that the agreements had to be carried further because of the special problems of administration created by the migratory habits of frontier raiding tribes.[3] By the terms of the Bahra Agreement of November 1, 1925, the two governments mutually undertake to use all the means at their disposal other than expulsion and force to prevent unauthorized migration across the frontier. Raiding by tribes across the frontier zone into the territory of a neighbor is recognized as aggression subject to severe punishment. A special tribunal is provided to inquire into the particulars of aggression, assess the damages and losses, and fix the responsibility; and the decisions of the tribunal shall be final and executory. Tribes subject to one of the governments may not cross the frontier into the territory of the other government except by permit if the migration of the tribe is due to the necessities of grazing.

Of the same sort as the foregoing agreements is that made between the governments of the Nejd and of Trans-Jordan, the Hadda Agreement of November 2, 1925. Permits, conditions of migration, display of flags by sheiks of tribes, raiding and tribunals to deal with questions of aggression and damage are treated along similar lines. In this part of the boundary some particularly interesting questions arise.

The northerly extension of the Nejd in the region of Kaf at the eastern border of the Trans-Jordan country represents an intense conflict of tribal interests in which Ibn Saud came off victor. The real struggle between him and the British negotiators centered upon the Wadi Sirhan, which extends between Kaf and Jauf. The recent conquest of Jauf by Ibn Saud placed his tribesmen at the entrance of Wadi Sirhan, and he contended for the possession of the whole of it. It happens that the principal Trans-Jordan tribes use the wadi in the winter and spring, moving northward to the Damascus region in the summer. An effort was made to keep Ibn Saud out of the Wadi Sirhan, not merely for the protection of these tribes but also because the depression is largely frequented by the Ruwala nomads, who occupy the region through which runs the route from 'Iraq to Syria.

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[3] See Report . . . on the Administration of 'Iraq for the Period April, 1923–December, 1924, [British Colonial Report] *Colonial No. 13*, 1925, pp. 42–51.

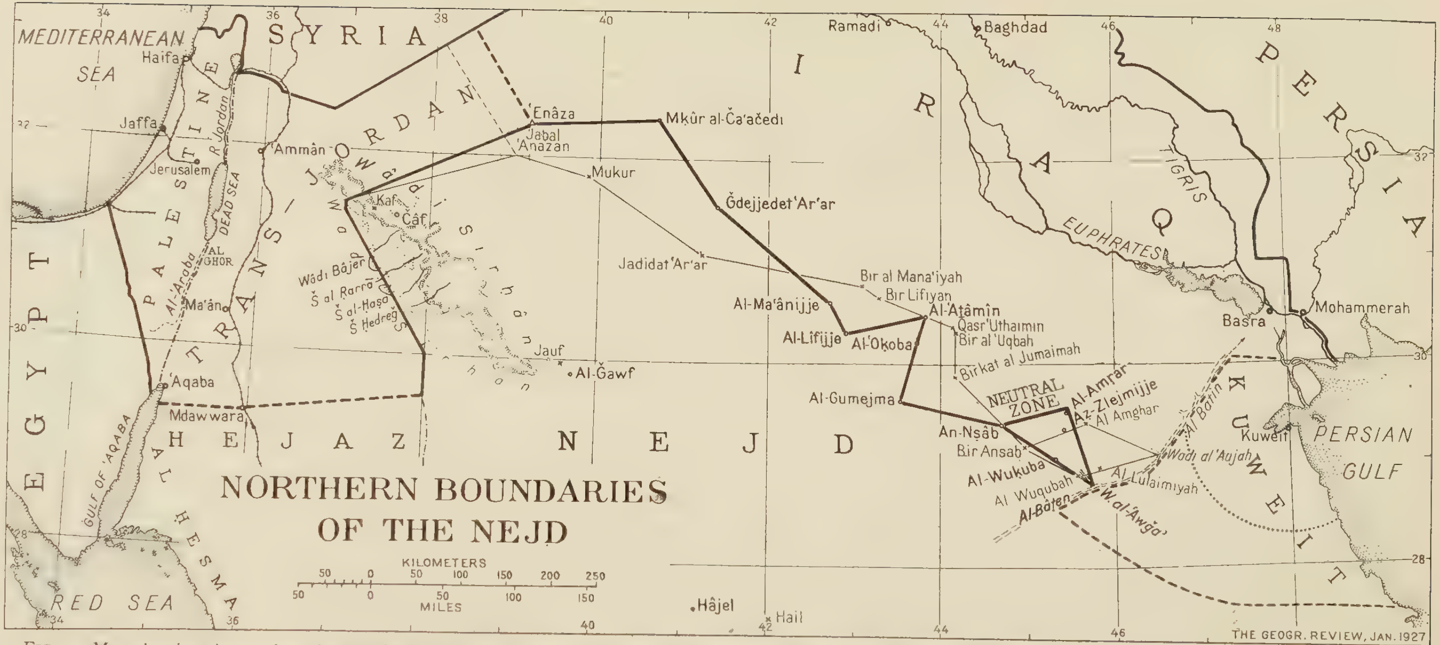

FIG. 2—Map showing the northern boundaries of the Nejd. Scale, 1: 8,250,000. There are considerable discrepancies in the charted positions of places in Arabia. The 'Iraq-Nejd boundary is defined by natural features, consequently its course varies according to the map upon which it is plotted. The Trans-Jordan-Nejd boundary, while defined in mathematical terms, also carries reference to certain natural features. The heavy line shows the boundaries as plotted on Professor Alois Musil's map of Northern Arabia, 1: 1,000,000, accompanying the account of his explorations in Arabia and Mesopotamia (1908–1915) now in course of publication by the American Geographical Society. Musil's rendition of Arabic names is shown in heavy lettering. The light line shows the boundaries as plotted on the International Millionth Map (Basra and El Djauf sheets) which was used in drawing up the Mohammerah Agreement. Rendition of the Arabic names in the treaty is in hair-line lettering. Attention is called to discrepancies in position of Jabal 'Enâza (Anazan) and especially to the Wadi Sirhan. Musil's version of the Wadi Sirhan is shown by a hachured border: the Millionth Map version by a fine dotted line. The four important wadis entering the Sirhan from the west are according to Musil. Were the Millionth Map version followed these wadis would be west of the Nejd-Trans-Jordan boundary as described in the treaty. The treaty in assigning the whole of the Wadi Sirhan to the Nejd further makes allowance for the "projecting edges" cut by the mathematical line on the base of the Millionth Map. [Note: in the Neutral Zone for Al-Wukuba read Al-'Okoba and for Al-Zlejmijje read Ad-Dlejmijjât.]

The southern boundary of Trans-Jordan has not been delimited, because of unstable conditions in the northern districts of the Hejaz. The broken line shows what appears to be the accepted British view of this boundary. The boundary between Trans-Jordan and 'Iraq also has not been delimited: the broken line shows the provisional boundary for administrative purposes.

In the case of Kuweit the dotted line shows the arc of 70 miles radius, the dashed line the sphere of influence of 1913. However, Philby in the Encyclopædia Britannica, 13th edition, Supplementary Volume I (dated Sept. 1, 1926, under Arabia-Kuwait, p. 154) states that the Kuweit boundary was agreed upon in 1921. His map credits Kuweit with a somewhat smaller area and shows another neutral zone in southern Kuweit.

This British corridor between Palestine and 'Iraq is regarded as of much importance. Through it runs the Imperial Air Route to the East. It is probable that an oil pipe line will be laid from Mosul to Haifa and possibly a Baghdad-Haifa railroad may be constructed.

Kaf is an extremely important strategic outpost of the Trans-Jordan country from which Ibn Saud could launch attacks upon the Trans-Jordan tribes and settlements and propagandize at will among the Ruwala. In addition to the Wadi Sirhan are the four wadis Bayer, Gharra, Hasa, and Hedrej. These lie east of the Damascus-Medina, or Hejaz railway, as it is called, and the tribesmen who occupy them range eastward partly into the Wadi Sirhan and partly westward up to and even across the railway. Some of them, as, for instance, the Jawazi section of the Huwaitat, winter in the Ghor (the deep depression partly occupied by the Dead Sea and the River Jordan) and in the continuation of this depression southward toward the Gulf of 'Aqaba known as Al 'Araba. As finally drawn, the boundary runs in such a manner as to include the Hejaz railway in the Trans-Jordan country, and it also leaves the four wadis just mentioned in the Trans-Jordan but cuts off the more easterly summer grazing grounds of the tribesmen, swings around Wadi Sirhan, and puts in the hands of Ibn Saud a valley upon which he can base attacks upon both the railway and the country west.

Texts of Agreements

The following description and interpretation of the texts of various agreements relating to the boundaries of the Nejd has been made with the assistance of Colonel Lawrence Martin, Chief of the Division of Maps of the Library of Congress. Professor Alois Musil has given help in the construction of the map of the northern boundaries of the Nejd.

The Sultanate of Nejd includes the formerly independent Kingdom of The Hejaz and the Amirate of Jabal Shammar, as well as parts of El Hasa, Asir, and Yemen, etc. Its boundaries are as follows:

I. *On the northwest and west*, with Trans-Jordan, for which Great Britain is Mandatory [the boundary is described from east to west to south]:

(1) "The frontier between Nejd and Trans-Jordan starts in the northeast from the point of intersection of meridian 39° E. and parallel 32° N., which marks the termination of the frontier between Nejd and 'Iraq, and proceeds in a straight line to the point of intersection of meridian 37° E. and parallel 31° 30′ N. and thence along meridian 37° E. to the point of its intersection with parallel 31° 25′ N. From this point it proceeds in a straight line to the point of intersection of meridian 38° E. and parallel 30° N., leaving all projecting edges of the Wadi Sirhan in Nejd territory, and thence proceeds along meridian 38° E. to the point of its intersection with parallel 29° 35′ N." [From the *Hadda Agreement*, Nov. 2, 1925, between the High British Government and the Sultan of Nejd and its Dependencies, "Agreements with the Sultan of Nejd Regarding Certain Questions Relating to the Nejd-Trans-Jordan and Nejd-'Iraq frontiers," Cmd. 2556, 1925, Article 1, page 3.]

(2) From the point at the junction of the meridian of 38° E. and the parallel of 29° 35′ N. the boundary is understood to extend westward to the Hejaz Railway at Al Mudawwara and thence due west to a point on the Gulf of 'Aqaba south of the port of 'Aqaba.

(3) The remainder of the western boundary of Nejd is the Gulf of 'Aqaba and the Red Sea.

II. *On the north*, with 'Iraq and the Neutral Zone [the boundary is described from east to west]:

"The frontier from the east begins at the junction of the Wadi al 'Aujah (W. el Audja) with Al Batin, and from this point the Najd frontier passes in a straight line to the well called Al Wuqubah (El Ukabba), leaving Al Lulaimiyah (Dulaimiya) and Al Wuqubah (El Ukabba) north of the line, and from Al Wuqubah (El Ukabba) it continues N.W. to Bir Ansab (Bir Unsab).

"Starting from the point mentioned above, i. e. from the point of the junction of the Wadi al 'Aujah (W. el Audja) with Al Batin (El Batin), the 'Iraq boundary continues in a straight line N.W. to Al Amghar (El Amghar), leaving this place to the south of the line, and from thence proceeds S.W. in a straight line until it joins the Najd frontier at Bir Ansab (Bir Unsab).

"The area delimited by the points enumerated above which includes all these points will remain neutral and common to the two Governments of 'Iraq and Najd who will enjoy equal rights in it for all purposes. [This zone contains many wells.]

"From Bir Ansab (Bir Unsab) the boundary between the two States proceeds N.W. to Birkat al Jumaimah (Birkat al Djumeima) and from thence northwards to Bir al 'Uqbah (Bir el Akaba) and Qasr 'Uthaimin (Kasr Athmin), from there westwards in a straight line passing through the centre of Jal al Batn (Djal el Batn) to Bir Lifiyah (Bir Lifa) and then to Bir al Mana'iyah (Bir el Maniya) and from there to Jadidat 'Ar'ar (Dja-daidat el Arar), from there to Mukur, and from Makur to the Jabal 'Anazan (Anaza), situated in the neighbourhood of the intersection of latitude 32° (east-north) with longitude 39° (north-east) where the 'Iraq-Najd boundary terminates." [From the *Mohammerah Agreement*, May 5, 1922, Treaty and Undertakings in Force Between the Government of 'Iraq and H. H. The Sultan of Najd, Protocol No. 1 of Dec. 2, 1922, Article 1.]

III. *On the northeast and east*, with the Sultanate of Kuweit and the Persian Gulf.

"In the Anglo-Turkish Convention of 1913 the area under the direct control of the Shaikh of Kuwait had been defined on the map by a red circle with a radius of some 70 miles from Kuwait on all sides, while a farther area, from Umm Qasr to Al Ratk, thence down the Batin to Hafar and eastward to the Persian Gulf which it reached at Jabal Manifah, some 200 miles south of Kuwait was recognized as being within his sphere of influence." [Rept. on 'Iraq Administration for the period October 1920–March 1922.]

IV. *On the south*, with the British hinterland of Aden, and the Imamate of Yemen:

(1) "In April, 1905, after demarcation of the frontier [of Aden], Ottoman and British Commissioners signed an agreement which determines the boundary of the hinterland from Sheikh Murad on the Red Sea to Bana river, and thence north-east to the great Desert. By the Anglo-Turkish Convention of 1914, the boundary was prolonged through the desert to a point on the coast opposite Bahrein in the Persian Gulf." [The Statesman's Year-Book, 1926, p. 92.]

(2) The eastern boundary of Yemen is entirely undefined. The map, Figure 1, shows a conventional boundary based upon all available data as to which sheikdoms and villages pay tribute to and acknowledge the Imam of Yemen and which the Sultan of Nejd.

THE PROBLEM OF COAST PROTECTION

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EVERY winter the public press records ravages effected by storm waves on one or more parts of our exposed coast. Now it is New Jersey which is the victim, with board walks and boulevards undermined and costly summer residences and big hotels destroyed. Again Florida is the sufferer, and columns of print are required to chronicle the devastation wrought by wind and sea along the margins of the land of fruit and flowers. The Galveston disaster is still fresh in memory. At one time or another the ocean takes toll of every coastal state from Maine to Texas and from southern California to the northern shores of Washington.

The problem of coast protection is becoming more acute every year. The automobile is bringing the population of the interior to the seashore in ever increasing crowds, property values along the sea are mounting rapidly, and demands for good bathing beaches are forcing municipalities to expend millions to preserve present beaches from destruction or to create new beaches where naturally only mud flats or jagged rocks were found. Unfortunately efforts at beach formation and coast protection have too frequently proved of little effect.

Coöperative Study and Action Necessary

Only through coöperative studies extending over a long stretch of sea front can there be collected a large body of carefully observed facts from which may be disengaged the general principles controlling coast erosion. Shore processes are peculiarly complex. Wave action varies with the strength of the wind, with the direction from which it blows, with the extent of open water over which it passes, with the depth of the water, with the form of the sea bottom, with the shape of the shore line, with the direction of tidal or other currents, with the height of the tide, and with other factors. Current action is similarly variable. At no two places on the coast do natural forces operate in precisely the same manner; and seldom, if ever, do they behave twice in precisely the same manner at any given point.

Coöperation in the work of designing and constructing coast defenses is equally necessary. The writer has elsewhere described the damage wrought on well protected property where the waves "outflanked" the defenses by first attacking unprotected areas on either side.[1] On the shore every man is his neighbor's keeper. Even the man back of the shore is vitally concerned in the matter of coast protection, for he must pay, in the form of increased taxes, for every foot of land conquered by the sea. The city, the county, and the state are interested parties, since they all suffer when land and buildings are destroyed, just as they gain when shore resorts become great contributors to their wealth. The federal authorities are concerned; for, even if it should ultimately be decided that coast protection is a duty of state governments rather than of the federal government, it must always remain true that the United States Coast and Geodetic Survey, the United States Army Engineers, and other federal organizations will be among the most important agencies engaged in studies of coastal phenomena and coast-protection devices.

THE ASBURY PARK MEETING

For several years the Committee of Shoreline Investigations of the National Research Council has been working toward this end and has brought about significant coöperation of federal, municipal, and private agencies in the study of certain specific questions.[2] On the 14th and 15th of last October, a step of unusual importance was taken at Asbury Park, N. J., when there was held the first conference of federal, state, and municipal authorities for the discussion of coast erosion and protection. The conference was called on the initiative of Commander R. S. Patton of the Coast and Geodetic Survey, the present chairman of the Committee on Shoreline Investigation named above and actively associated with the New Jersey Board of Commerce and Navigation. Invitations were issued to the coastal states by Governor Moore of New Jersey. Every state on the Atlantic Coast, except one, and two Gulf Coast states responded by sending delegates.

The meeting was devoted mainly to informal discussions of coastal problems in different states by the delegates, under the chairmanship of J. Spencer Smith, president of the New Jersey Board of Commerce and Navigation. The general trend of the discussions laid emphasis on the facts presented in the first part of this paper. Among the interesting details brought out, several deserve special mention. Federal improvements at the mouth of the Savannah River, at the Delaware Breakwater, and elsewhere have been followed by damage to adjacent coastal areas, this damage being attributed by some to changes in the equilibrium of shore forces consequent on the improvements. Wrightsville Beach, N. C., an incorporated town with a winter population of 22 persons and a summer population of 5000, spent $30,000 three years ago building wooden jetties to check erosion; those lasted but a short time, and another $30,000 has since been spent in building concrete jetties. At Stamford, Conn., a public park was made by filling sand over peat bog at a cost of $500,000, while a bathing pavilion was erected at a cost of $125,000; retreat of the shore line is placing the pavilion in danger of being undermined, and the need of protective measures is urgent. At a single point on the New Jersey Coast $350,000 was spent on shore protection to little effect, as storm waves soon destroyed the protective works. Extensive improvements at Coney Island have included the creation of a new beach by artificial sand deposition on a grand scale, with results thus far generally good, although replacement of eroded sand on part of the beach has been necessary. At Atlantic City jetties constructed on an extensive scale have given satisfactory results, much land having been added to the beach front where the checking of longshore currents has caused sand deposition. Excessive damage at Long Beach, N. Y., has resulted in contracts being let for 51 jetties and in the floating of a bond issue of half a million dollars, 40 per cent of the cost to be assessed on ocean-front property holders, 60 per cent on residents back of the beach. On part of the Massachusetts coast $250,000 has been spent in protecting a water front of eleven miles. Mississippi is meeting the problem by the issue of $3,400,000 in bonds for coast-protection works and by building what is said to be the longest concrete sea wall in the world; fourteen miles are already completed, and the finished wall will have a length of 24 miles.

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[1] D. W. Johnson and W. S. Smith: Recent Storm Effects on the Northern New Jersey Shoreline and Their Supposed Relation to Coastal Subsidence, *Geol. Survey of New Jersey Bull. 12*, 1914, pp. 27–44.

D. W. Johnson and W. S. Smith: Wave Work on the New Jersey Coast, *Popular Sci. Monthly*, Vol. 86, 1915, pp. 557–567.

[2] Some account of the work of this Committee will be found on another page of this issue of the *Geographical Review*.

The major result of the meeting was a resolution looking forward to the creation of an association of the states adjacent to the Atlantic and Gulf coasts for a concerted coöperative attack upon the problems of common interest. A first step in this direction was the appointment of an Executive Committee constituted as follows: J. Spencer Smith, chairman; R. S. Patton, U. S. Coast and Geodetic Survey, secretary; and one member from each of the following groups of states—Maine to Connecticut inclusive, New York to Virginia inclusive, North Carolina to Florida inclusive, Alabama to Texas.

This Executive Committee met at Norfolk, Va., on October 20. It perfected plans for a permanent organization, drafted a constitution and by-laws, determined upon the permanent committees to be set up, and proceeded to the selection of personnel for such committees. Before these pages go to press, all the steps indicated will have been submitted for ratification to a meeting of the association called at Washington, D. C., on December 8 in the building of the National Research Council. One of the most encouraging features about the whole effort is the rapidity with which progress is being made, a hopeful indication of real public earnestness.

DE FILIPPI'S EXPLORATIONS IN THE HIMALAYA, KARAKORAM, AND CHINESE TURKESTAN: A REVIEW

De Filippi's remarkable explorations in the mountains and plateaus between the Vale of Kashmir and Chinese Turkestan were carried out in 1913–1914, but owing to the war the published results have been appearing only during the last four or five years. These publications, though they are not as yet complete, have progressed far enough to give us an idea of the extraordinarily comprehensive work accomplished. It is probable that no exploring expedition by land outside the polar regions has ever been so elaborately equipped or carefully planned or has yielded such a harvest of scientific results. That this was possible was due partly to the leader's talent for organization and partly to the material aid received from the Italian Government, the Government of India, the Royal Geographical Society of London, and other institutions in the form both of funds and of loans and gifts of instruments.

Sir Filippo De Filippi accompanied the Duke of the Abruzzi on the latter's expeditions to Mt. St. Elias, Ruwenzori, and the Karakoram. While working up bibliographical data in connection with his narrative of the Duke's Karakoram expedition, De Filippi tells us that he became aware of "the variety and the importance of the problems as yet unsolved" which the region about the upper Indus and upper Yarkand Rivers offered to the explorer. Thus originated the plan for his own expedition. But unlike the Duke, who was primarily interested in exploratory mountaineering as a sport, De Filippi was concerned first and foremost with scientific exploration; hence a distinguished group of scientists was invited to make up the party.

Geodetic, astronomical, geophysical, and topographical work was carried out by (naval) First Lieutenant (now Captain) Alberto Alessio and by Professor Giorgio Abetti of the University of Rome. Professor Giotto Dainelli of the University of Pisa and the late Professor Olinto Marinelli of the University of Florence devoted themselves to geology, geography, and anthropology. Dr. Camillo Alessandri, Director of the Monte Rosa Observatory and meteorologist of the Hydrographic Office in Venice, and the Marchese Nello Venturi Ginori specialized in meteorology and related studies. The Trigonometrical Survey of India was represented by Major (now Lieutenant Colonel) Henry Wood and by an engineer, Mr. J. A. Spranger, assisted by two Indian surveyors. Lieutenant (now Major) Cesare Antilli was in charge of photography. An Alpine guide, Giuseppe Petigax, who had also accompanied the Duke of the Abruzzi, rendered valuable services on the glaciers.

Route of Expedition

Leaving Srinagar, Kashmir, on September 21, 1913, the party crossed the main range of the Himalaya by the Zoji La and arrived at Skardu in Baltistan on October 25. On traversing the Himalaya they entered a country which had been visited by not a few earlier European travelers but one in which relatively little scientific exploration had been carried out on a comprehensive scale either as regards natural history or human geography. Consequently, De Filippi and his associates proposed not merely to examine a narrow band along the caravan route from India into Central Asia but rather, by taking plenty of time and by sending out side parties, to explore as much as possible of the entire tract lying between the Karakoram and Himalaya and extending southeastward to the Tibetan borderlands. Thus, while some of the party remained at temporary headquarters established at Skardu taking gravimetric, astronomical, and meteorological observations, Dainelli made long excursions through the valleys south of the Karakoram glaciers. Other travelers have stressed the difficulties of winter journeys among these bleak highlands. Dainelli tried the experiment of winter traveling and found that his movements were facilitated rather than hindered by the frozen rivers and snow-covered ground.

On February 16, 1914, the party as a whole left Skardu and proceeded up the valley of the Indus to Leh, the capital of Ladakh, which was reached on March 26. While preparations were being made here for the summer campaign to the north, Dainelli visited the remote and lofty Rupshu plateau lying some eighty miles to the southeast. After the main party had been joined by Marinelli, Alessandri, Wood, Spranger, and the two Indian surveyors—who had not taken part in the work accomplished up to that time—, it left Leh on May 15 and made its way across the Chang La and through the upper Shyok valley to the desolate upland of Depsang. Here, at an altitude of 17,590 feet, not far south of the famous Karakoram Pass and within view of the easternmost glaciers of the Karakoram Range, a temporary base was established, at which during two and a half months, Alessandri and Venturi Ginori took frequent meteorological observations (hourly, during July). From this base Dainelli and Marinelli visited the upper valley of the Karakash River to the east, while Wood and Spranger were making a careful survey of the Depsang upland and neighboring valleys and Alessio and Abetti were busy with gravimetrical and astronomical work.

The main phase of pioneer exploration was carried out during July and early August among the eastern glaciers of the Karakoram and between these and the caravan route over the Karakoram Pass. This region had previously been mapped only very sketchily; the De Filippi expedition showed that earlier ideas regarding it were entirely erroneous, especially as relating to the main line of the continental divide between the watersheds of the Indian Ocean and the interior basin of Chinese Turkestan. The De Filippi expedition made the striking discovery that, whereas the three main arms of the great Remo glacier contribute to the Shyok and thence to the Indus, a branch leading out of the northern arm gives rise to the headwaters of the Yarkand. The Remo glacier thus lies astride the divide.

On August 16, three days after the whole expedition was reunited at the base camp, news was brought by couriers from India of the outbreak of the World War. This necessitated the immediate return of Alessio, Antilli, and Alessandri. The others proceeded northward, crossing the Karakoram Pass together but subsequently dividing and making their way to Karghalik in the lowland of Turkestan in separate parties and by various routes, the details of which we need not specify. From Chinese Turkestan the return to Europe was accomplished over the Pamirs and thence by way of the Transcaspian and Transcaucasian railways.

PUBLISHED RESULTS

The outstanding publications relating to the expedition consist of a monumental series of official reports and two popular books—all in Italian. The work carried out by the British detachment under Colonel Wood is narrated in English in a volume published in 1922 by the Trigonometrical Survey of India.

The scientific reports of the expedition's work are to be embodied in thirteen magnificent volumes, comprising two series. The first series, edited under the direction of De Filippi himself, will consist of three volumes: Vol. 1, "Astronomia geodetica, geodesia e topografia"; Vol. 2, "Geofisica: gravità e magnetismo"; and Vol. 3, "Geofisica: meteorologia." Of this series the first volume only has as yet been published. The second series, on geology and geography, is being edited under the direction of Professor Dainelli and will comprise ten volumes, of which three have appeared to date: Vol. 1, "Storia dell'esplorazione: itinerari e ricerche"; Vol. 2, "Le serie dei terreni"; Vol. 3, "Studi sul Glaciale" (published in 1922); Vol. 4, "Le condizioni fisiche attuali"; Vol. 5, "I fossili del Paleozoico"; Vol. 6, "I fossili del Mesozoico e del Terziario"; Vol. 7, "Le rocce"; Vol. 8, "Le condizioni delle genti" (published in 1924); Vol. 9, "I tipi umani" (published in 1925); Vol. 10, "Raccolte di piante e di animali. Indici analitici." These publications show every evidence that the care both for detail and completeness which went into the organization and equipment of the expedition is also being devoted to the presentation of its results. These volumes, as well as De Filippi's popular narrative (noted below) are being published by Nicola Zanichelli, Florence.

Geodetic Astronomy and Topography

Volume 1 of the First Series is due to the coöperative enterprise of Abetti, Alessio, Antilli, Spranger, Venturi Ginori, and Wood. It opens with a brief prefatory narrative of the expedition as a whole by De Filippi himself. This is followed by full expositions of the astronomical position finding, the triangulation, the barometric and boiling point determinations of altitude, and of the photographic work accomplished. The illustrations show the instruments used and methods of carrying them, as well as the trigonometric, radio, and barometric stations set up; they also include outline diagrams of the various triangulation nets. The work described was carried on with a double end in view, partly for the positive facts to be derived from it and partly for its experimental value. No accurate triangulation had hitherto been made either of the main chain of the western Himalaya or of the eastern Karakoram. In establishing fixed points for the benefit of more detailed future topographical surveys, the expedition was performing a pioneer service, from which the geophysicist and geologist as well as the topographer of the future will benefit. The region is one of active tectonic movements: these can be detected and measured only when positions and altitudes have been ascertained with precision. The experimental aspect of the work, however, was of no less significance. This was one of the first expeditions in which the reception of wireless time signals was used as a basis for position finding. The relative degrees of accuracy attainable by the use of different methods and different types of instrument and the absolute degree of accuracy that may be achieved by a party working under particularly trying conditions of weather and terrain were held to be eminently worth finding out for their own sake if for no other reason. The expedition aimed to set a high standard of performance in the field.

Glaciology

In Volume 3 of the Second Series Professor Dainelli gives a detailed study of the glacial history of the Upper Indus watershed and the Vale of Kashmir. The scattered and uncoördinated observations of earlier travelers had failed to present an adequate view of the extent of the Quaternary glaciation in these regions. Indeed, the opinion prevailed that while the Quaternary glaciers were somewhat larger than those of the present day, the Indus valley itself was free from ice. Professor Dainelli discusses critically the published views of others in this regard, comparing them with the results of his own observations. His general conclusion is that land forms directly attributable to ice action are represented throughout the upper Indus valley above Skardu and provide indubitable evidence of extensive glacial erosion and deposition. There were, apparently, four main glacial stages. During the first two the Indus valley itself was occupied by a valley glacier formed by the combined glaciers coming down the side valleys from the Himalaya and Karakoram. During the third and fourth stages, though the Indus valley was not actually occupied by ice, it was modified by the accumulation of lacustrine and fluvial deposits associated with an expansion of the glaciers in the neighboring mountains. The Indus valley appears to have been dammed near Skardu by the tongue of a side valley glacier, and a long lake was thus created, stretching for a distance of over 130 miles. The volume concludes with a treatment of the glacial beds and lake levels in the Vale of Kashmir. A separate volume of photographs and maps accompanies the text.

HUMAN GEOGRAPHY

Professor Dainelli is no less competent in the field of human geography than in that of physiography. Volumes 8 and 9 of the Second Series supply us with the results of his very thorough investigations of man in the parts of Kashmir lying in the watershed of the upper Indus. Dainelli's personal observations are particularly valuable in this respect, because, unlike previous travelers, he did not hesitate to avail himself of native hospitality whenever possible. By actually staying in native dwellings he was enabled to learn much of local customs and character that would have been overlooked by the traveler who kept to his own tents. Dainelli correlates his personal observations in every case with what other travelers have written about the region. A critical examination of the results of the census of 1911 is made the basis for much of the demographic material in these two volumes.

Volume 8, "Conditions of the People," is primarily a monograph in anthropogeography. Two main topics are dealt with: the character of settlements (including lines of communication) and the distribution of peoples and of different kinds of cultivations. In his treatment of the character of the settlements Dainelli aims to work from the least to the most complex aspects of the subject. The human habitation being the fundamental unit of settlement, he first discusses house types. These, he finds, seem to fall into several well differentiated groups, each with a clearly defined area of distribution. The simplest habitation of all is the tent of the Changpà nomads of the great plateaus of western Tibet and eastern Ladakh. The houses of the Changpà who have adopted an agricultural régime and established permanent dwellings still retain some of the characteristics of the tent. In general, however, the Tibetan house type prevails, although the dwelling of the Buddhist Ladakhis is more closely related to the typical Tibetan house than that of the Moslem Baltis. The latter is usually ruder and less comfortable and would seem to represent a modification of the Tibetan form under the influence of climatic, economic, and cultural conditions.

The centers of population are not as distinctive in their grouping and internal arrangement as are the house types in their form. In general the former may be classified as either minor centers, predominantly agricultural, or major centers, with bazaars and, hence, of some commercial pretensions; but of the second type there are only six examples in the entire region studied.

Settlement follows the principal drainage lines. The mountain ridges and lesser valleys are utterly barren, uninhabited wastes. In the sense that they are isolated from each other by desert mountains and inhospitable stretches of valley, the settlements of Baltistan and Ladakh may rightly be called "oases." Agriculture depends entirely on irrigation. As the natives have not been able to devise means of raising water from the rivers to fields lying at higher elevations than the stream channels, irrigation for the most part is possible only on the alluvial cones built out by tributaries into the valleys of main streams. On these cones cluster the houses of the isolated "oases."

The upper limits of settlement are determined mainly by climatic and physiographic conditions. Dainelli has attempted to draw a contour map (p. 177) showing the upper limit of permanent settlement throughout the region. In general this rises as one approaches the Karakoram and as one goes southeastward toward the plateaus of Tibet. The highest permanent settlement in the whole region is at the Garzok-

Gompa (monastery) on the Rupshu Plateau, at an altitude of 15,040 feet. Dainelli states that this is the highest settlement in the world where there are fixed houses inhabited by non-nomadic families among cultivated fields. Parenthetically it may be noted that the highest permanent habitations of a pastoral people would seem to be at an elevation of 17,000 feet and more (Isaiah Bowman: The Andes of Southern Peru, *Amer. Geogr. Soc. Research Ser. No. 2*, 1916, p. 52).

The population of the region, as a whole, has been gradually increasing of late years. Dainelli's discussion of the density of population in relation to twenty-five natural regions into which he subdivides Ladakh and Baltistan is of value both for the light which it sheds on existing conditions and as a contribution to the methodology of the geographical study of population. Our only regret is that for the two maps showing densities of population the colors and tints were not better selected to bring out gradations from less to more thickly settled areas. Besides dealing with the distribution of individuals, Dainelli gives an extensive and illuminating treatment of the distribution of house types, centers of population, religions, languages, social statuses, agricultural enterprises, and vegetation types.

In Volume 9 Professor Dainelli turns from anthropogeography to ethnology: from the discussion of the distribution of human phenomena to a discussion of the people themselves and of their social and religious institutions. These folk fall into several groups, of which the Baltis and Ladakhis are the most important numerically. Between the Baltis and Ladakhis live the lesser intermediate groups, Puriks and Makhnopa (or "Indus Dards"); west of the Baltis dwell the Brokpa, or Dards; and east of the Ladakhis the Changpà nomads occupy the upper Indus valley as winter headquarters, wandering widely upon the neighboring wind-swept plateaus in the summer. The essential differences between the Baltis and the Ladakhis Dainelli believes should be attributed to their religions, the Ladakhis being Buddhist, the Baltis Mohammedan. To this difference Dainelli would ascribe the very marked divergences between these people in culture, art, and character. The Baltis are polygamists, the Ladakhis polyandrists. Whether or not the latter became polyandrous through the compulsion of environmental forces, as some have claimed, Dainelli believes that to polyandry may be attributed their superior prosperity. In a polyandrous society the number of families is fixed and the population as a whole remains stationary, even though individual families may be large. The Ladakhis build better houses, are more cheerful, more adventurous, more open to suggestion, and on the whole more "civilized" than their Moslem neighbors.

The last part of the ninth volume is an analysis by Professor Renato Biasutti of 408 somatic observations made by Dainelli.

Popular Narratives

Before closing, a word must be said of the two popular books dealing with the expedition. The first to appear was the delightfully written personal journal of Professor Dainelli entitled "Paesi e genti del Caracorùm" and published under the auspices of the Reale Società Geografica Italiana in 1924. Since much of Dainelli's work was done apart from the rest of the expedition, these volumes do not cover the same ground as that covered by De Filippi in his "Storia della spedizione scientifica italiana nel Himàlaia, Caracorùm, e Turchestàn Cinese" (1913–1914). The latter is a beautiful piece of work both from the literary and typographical points of view. Dainelli and Spranger contribute chapters on phases of the exploration with which they were connected. Writing in clear attractive style, the authors give enough incident and color to make a thoroughly absorbing story; at the same time they furnish sufficient scientific detail and argument to familiarize the reader with the more important constructive results of the expedition. The volume is fully illustrated with maps and photographs (including many panoramas) and with two exquisite reproductions in color of landscape paintings.

AMERICAN GEOGRAPHICAL SOCIETY

The November Meeting. The first regular meeting of the American Geographical Society for the season 1926–1927 was held on November 23, 1926, at the Engineering Societies Building, 29 West 39th Street, President John H. Finley in the chair. Dr. Knud Rasmussen spoke on "Across Arctic America," honoring the Society by making this his first public appearance in America. In a series of still and moving pictures he traced the route of the Fifth Thule Expedition, in which he and two Eskimo companions traveled by dog sledge for 10,000 miles along the northern coast of North America, visiting almost every known tribe of Eskimo. A preliminary report on the expedition appeared in the October, 1925, number of the *Geographical Review:* a detailed narrative account under the title "Across Arctic America" is now in press and will be reviewed subsequently in the *Geographical Review.*

In opening the meeting, President Finley referred to the presentation of the Charles P. Daly Medal of the Society to Dr. Rasmussen at Copenhagen in 1925, through the kind offices of the American Minister, Dr. Prince. In addition President Finley took occasion to present the medal of the League of Walkers to Dr. Rasmussen and to say that it was struck in gold for the first time in honor of his extraordinary journey. A duplicate was handed the explorer for presentation by him to Arnarulunguaq, the Little Woman, who accompanied him throughout his journey and who, after the return of the expedition, resumed her place in the Eskimo settlement at North Star Bay, Greenland.

Elections to Fellowship. At the November meeting of the Society, President Finley presiding, there were presented with the approval of the Council the names of 520 candidates who were duly elected as Fellows of the Society.

Distribution of Title Page, Contents, and Index of Vol. 16 of the Geographical Review. The title page, table of contents, and index for Volume 16 of the *Geographical Review* (1926), which is issued separately, will shortly be ready for distribution. Copies are sent to all institutions exchanging publications with the Society and to individuals who request that their names be put on a list for this purpose.

Presentation of the David Livingstone Centenary Medal to Luis Riso Patrón. The presentation of the David Livingstone Centenary Medal for 1925 to Dr. Luis Riso Patrón took place on September 14, 1926, at the American Embassy, Santiago. The reception tendered on the occasion was attended by the Minister of Foreign Affairs and other officials of the Foreign Office, members of the Diplomatic Corps and scientific circles and leading members of the American colony in Santiago. The ceremony was arranged by Chargé d'Affaires C. Van H. Engert. In making the presentation he spoke in part as follows:

"The American Geographical Society, in conferring this medal upon you, Dr. Luis Riso Patrón Sanchez, has borne in mind your many claims to special distinction in the field of exploration and geographical research: the fact, for example, that you headed the first Chilean Commission to make an accurate survey of the Cordillera de los Andes; that you explored hitherto unknown parts of the Lago San Martin region; that you conducted surveys of the Chile-Argentine and Chile-Bolivian boundaries; that you have edited topographic maps of these boundaries as well as the Chilean sheets of the International Map of the World; and that you are the author of the monumental Geographical Dictionary of Chile and of other important books and articles too numerous to mention on the Cordillera and on the history of exploration in the Americas.

"I deem it a great privilege indeed to present to you this gold medal on behalf of the American Geographical Society not only in recognition of your great merits as a scholar but also, I know, as a token of the high esteem in which you are personally held by your many friends in the United States."

In accepting the medal Dr. Riso Patrón expressed his appreciation of the award and of the occasion on which it was presented. He concluded with a plea "for development of geographical study and national cartography which themselves more than repay any sums that may be devoted to the purpose."

Recent Publications

China: Land of Famine. "It is a shocking fact that with all the labor expended and virtues practiced, nearly a fourth of the people of the globe live in a land of famine—not of general famine at any one time nor of continuous famine in any one place but of famine in one or another province or locality all the time" says President Finley in his foreword to Mr. Walter H. Mallory's book "China: Land of Famine," *Special Publication No. 6.* Mr. Mallory, who has had experience in relief work in many lands, has just completed five years service as secretary of the China International Famine Relief Commission. In this volume he gives his analysis of the problem, its causes and cures.

The book begins with a consideration of the economic conditions under which the people live. "Even in a normal year the bare food requirements are not met." Natural phenomena, the floods and droughts for which the plain of eastern China is notorious, precipitate serious states of famine. The political chaos under which the country is now suffering by its wasteful demands on resources and its neglect of famine-prevention measures, aggravates the evil. Back of all lies the fundamental cause, "a density of population greater than the land is able to support," a consequence of the high birth rate and the reluctance of the people to leave their ancestral homes. To change the customs and beliefs which are at the bottom of the multiplying force must be a slow process, such is the innate conservatism of the Chinese. But certain cures can be applied which will yield immediate results. In order of practical importance Mr. Mallory lists flood control, irrigation, and land reclamation; economic improvements, rural credit, colonization, and home and village industry; improved agriculture and forestation; development of transportation; and education (in the sense of book learning).

The volume is illustrated with over 90 photographs and 12 maps, as well as plans for flood control and land reclamation.

Peopling the Argentine Pampa. Professor Mark Jefferson was leader of the American Geographical Society's Expedition to South America in 1918. Study of modern colonization in Argentina, Brazil, and Chile was the prime purpose of this expedition. Results published heretofore include *Research Series Nos. 6 and 7*, "Recent Colonization in Chile" (1921) and "The Rainfall of Chile" (1921), and "Pictures from Southern Brazil" (*Geogr. Rev.*, Vol. 16, 1926, pp. 521–547). The present volume, *Research Series No. 16*, is a detailed and intimate study made possible by the additional basis of the author's residence in the Argentine from 1883 to 1889.

The historical and geographical setting is first laid before the reader. The Pampa is described before its transformation from a vast cattle range to an agricultural land at the hands of the immigrants. The essential contrast with the irrigated valleys of the west is pointed out. The beginnings of the immigration movement and its growth under the trend of political events follow in outline. The first agricultural colony, Esperanza, was established in Santa Fe in 1856. The history of this and other colonies of Santa Fe and Entre Ríos, successful and unsuccessful, is told in succeeding chapters largely by sketches of the personal history of families, that is in the terms of actual events, not of decrees or arrangements on paper. Obstacles in the way of satisfactory fulfillment of the colonization movement are pointed out in the chapter entitled "The Railroads and the Transformation of Agriculture." Immigration has developed the railway net and raised land values enormously; it has created the billion dollar grain and cattle exports, making the Argentine the business nation of South America, doing half the trade of the continent with one-seventh of the population; it has brought wealth to the Creole landowner. But the landowner has become correspondingly reluctant to part with his land. Today half the fertile land of the Pampa is occupied by the vast estates of cattle-raising Creoles: further progress rests in their hands. What a complete opening up of the country to colonization would mean is told in the final chapter, "Immigration as an Asset to the Argentine."

The volume is illustrated with 55 photographs and 13 maps and diagrams. Special mention may be made of the insert map, Plate I, showing stages in the growth of cities and railroads.

The Northern Ḥeǧâz. As already announced in the *Review* (Vol. 15, 1925, p. 297) "through the interest and generosity of Charles R. Crane, Esq., the Society is enabled to edit, publish, and distribute the results of thirty years' study of Arabian geography and history" on the part of Professor Alois Musil of Prague, "of which fourteen years were spent in the field." Professor Musil's work will be published in six volumes as the first contribution of the Society's new series, *Oriental Explorations and Studies*. The first volume, "The Northern Ḥeǧâz" (Hejaz), is now ready for distribution.

The main part of the volume consists of the narrative of a journey carried out in 1910. Leaving Ma'an on May 23, Professor Musil first visited an encampment of the Hwetat Bedouins in the desert some thirty miles east of the Hejaz Railway. Thence he proceeded to 'Aqaba by way of the Shera range and al-Homeima. From 'Aqaba he visited the ruins at the site of the ancient Madian (or Midian), going thence to Tebuk by way of Sharma. After a short sojourn at Tebuk he explored part of the *harra*, or lava-capped plateau to the south, touching the upper course of Wadi al-Jizel and returning along the railway line to Tebuk, which was reached on July 6. The return journey thence to Syria was made by rail.

The vivid narrative of events day by day is broken by detailed descriptions of the topography of the regions traversed, based upon the personal observations of the author and the examination of many natives. These topographical digressions serve in large measure as the explanation for a map (1:500,000) which accompanies the volume, the only detailed map of this little-known region in existence. As appendixes and footnotes there are full discussions of the Biblical, Assyrian, Greek, Latin, and Arabic notices of the Northern Hejaz. Among other matters here discussed are the probable route of the Exodus and the location of the Midianite tribes and the homeland of Job. The volume is fully illustrated with photographs, maps, and diagrams.

Index to the Geographical Review, Volumes I-XV, 1916–1925. This index, compiled by Arthur A. Brooks, is an analytical guide to the contents of the *Geographical Review*, the journal of the American Geographical Society of New York, for the first ten years (fifteen volumes) of its publication, that is from 1916 to 1925 inclusive. It is the chronological successor to the "Index to the Bulletin of the American Geographical Society, 1852–1915," published in 1918. The index to the *Bulletin* covered a longer period, but the present index is fuller and more analytical.

In this index are included subjects and authors of leading articles, subjects and authors of notes, and titles and authors of books, articles, and maps reviewed.

Practical Hints to Scientific Travellers, Volume IV. "Practical Hints" is a series of guides edited by Dr. H. A. Brouwer, professor of geology at the Technical University of Delft. By arrangement with the publishers, Martinus Nijhoff of the Hague, the volumes are distributed to American readers by the American Geographical Society. Volumes I, II, and III were issued in 1925 (see *Geogr. Rev.*, Vol. 16, 1926, pp. 307–308). Volume IV is now available. Its contents are: Egypt by O. H. Little; Angola by F. J. Faber; Australia by Griffith Taylor, R. Lockhart Jack, H. Basedow, R. H. Cambage, and Marjorie J. Shiels; Antarctica by Griffith Taylor; Venezuela by E. A. L. Gevaerts; Haiti by W. P. Woodring.

GEOGRAPHICAL RECORD

NORTH AMERICA

Shore Line Investigations on the Atlantic Coast of North America. At the October meeting of the National Research Council's Committee on Shoreline Investigations special attention was paid to the question of change in mean sea level in relation to change in shore-line conformation. It is customary to regard mean sea level as a constant; and differences at different periods, if not due to errors of determination, have been ascribed to changes in the altitude of the land relative to the sea. Recent researches on the supposed progressive subsidence of the Atlantic coast, however, suggest the possibility of local fluctuations of the datum line. Apart from the effect on bench marks the question has an immediate practical bearing, for erosion is more vigorous on a sinking coast line: property values are affected, the need of protective works arises, and litigation not infrequently ensues.

In pursuance of this line of investigation the Committee plans study of tide gauges at critical locations. The Canadian Hydrographic Office has promised tentatively to undertake such work at St. John, N. B. Here a large embayment, Kennebecasis Lake, connects with the outer harbor by a narrow inlet; the embayment receives a large quantity of fresh water, and the tidal range is very great. Other prospective sites are on Jamaica Bay, where conditions afford an instructive contrast, the tidal range being moderate and the connecting channels fairly wide, and at Eastport, Me., site of a scheme for the utilization of tidal power.

Another phase of the Committee's activities is the accumulation of a record of coast changes, as full and complete as possible. Data on erosion and accretion and of man's intervention in protective and improvement works are sought. Photographic records are specially valuable. The Committee asks coöperation from all persons or organizations interested. Communications should be addressed to Commander R. S. Patton, U. S. Coast and Geodetic Survey, Washington, D. C., or Professor Douglas Johnson, Columbia University, New York City.

Civic Planning for the San Francisco Bay Metropolitan Area. The San Francisco-Oakland agglomeration is already one of the great metropolitan areas of the world. The population now reaches the million mark; the district limits embrace 448 square miles. All circumstances indicate continued growth. The situation is strategic with regard to world trade routes, and there is a rich hinterland; the site offers excellent harbor facilities and conditions for industry; the region has climatic and scenic attractions. Mr. Charles H. Lee forecasts for the future metropolis a population of 5,000,000 to 6,000,000 (The Future Development of the Metropolitan Area Surrounding San Francisco Bay, *Bull. Seismol. Soc. of Amer.*, Vol. 16, 1926, pp. 81–132). It will occupy an area of 3730 square miles; extending outward an average radius of 40 miles from the Ferry Building of San Francisco. This area includes much rough land, but the part capable of intensive use will be not less than 876,300 acres.

The future metropolis will find the chief limiting factor to future growth in the water supply question. The great metropolitan areas of London and New York with their eight millions of people are situated in lands of humid climate. San Francisco is on the semi-arid border line. The most recent rainfall map of California gives San Francisco 20 inches per annum for the 25-year period ending 1919–1920 (Burton M. Varney: Seasonal Precipitation in California and Its Variability, *Monthly Weather Rev.*, April, 1925, pp. 148–163), and the variability is considerable. The city's present requirements of 100 million gallons a day are met from local sources entirely. These, it is estimated, could be developed to 250 million gallons. But the requirements of the future metropolis are placed at 1075 million gallons and would call for full development of plans now under way or projected on the Sierra streams and Eel River projects and would also draw on the Sacramento-San Joaquin River.

In planning for water distribution as for other public utilities the metropolis faces a special problem in earthquake risk. The larger the city the more serious the problem. "The risk from earthquake shock in a great city grows not simply in proportion to the population, but in the ratio of some indeterminate, higher power of their number," says Professor Bailey Willis in an introductory paper to Mr. Lee's study. Proper planning can greatly reduce the hazard. The increase of local water storage capacity, the use of all feasible regional sites for reservoirs, interconnection of systems to meet emergencies, avoidance of fault lines as far as possible are some of the safeguards to be considered. The systematic establishment of open spaces to act as fire-breaks is urged, and the promotion of earthquake-proof construction.

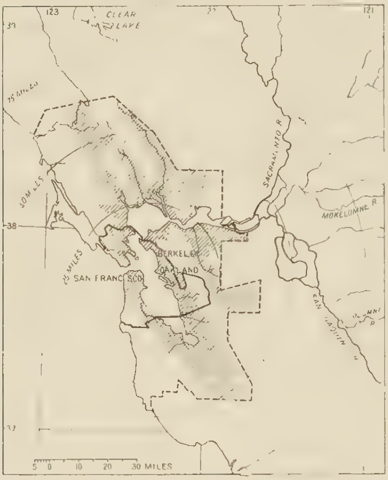

FIG. 1—Sketch map of the San Francisco region. The present metropolitan area shown by a solid line; the future area by a dashed line. The shaded area is adapted to intensive use; the dotted area can be made so by drainage. Scale of map approximately 1:4,000,000.

The distribution of the land area of the metropolis in a great ring about San Francisco Bay has a controlling influence on population distribution. It suggests certain advantages for the future—that the area develop on a small-unit community plan rather than about a single geographical center—but at the same time the isolated units need to be brought together for their common interests. The building of trans-Bay bridges would be an important contribution to this end. The proposed bridges, however, should not supplant the existing ferry service, the means of transportation least likely to interruption as a result of earthquake damage.

Saline Lakes of the Mohave Desert. During the potash shortage created by the World War Searles Lake came into prominence as a producer and has continued to produce while the majority of domestic sources declined on reëstablishment of the European industry. Under improved methods the Lake product can meet the price of the imported article. An investigation into the Franco-German monopoly by the U. S. Department of Commerce (H. M. Hoar: Potash: Significance of Foreign Control and Economic Need of Domestic Development, *U. S. Dept. of Commerce, Trade Promotion Ser. No. 33*, 1926) states that the output from the lake for 1924–1925 covered about ten per cent of American potash purchases.

The surface salt crust of Searles Lake is 50 to 75 feet deep, and salts occur as deep as the deepest boring—over 600 feet. Formed by evaporation from a large saline lake under a combination of unusually favorable circumstances the deposit is unique in the Mohave Desert (William F. Foshag: Saline Lakes of the Mohave Desert Region, *Econ. Geology*, Vol. 21, 1926, pp. 56–64). Most of the superficial salt concentration of the region occurs as playa deposits. The playas, accumulating in the lowest parts of the desert basins are classed as "dry" and "wet." The wet playas during the rainy season are generally occupied by shallow bodies of water and are more or less moist for the remainder of the year. The saline material is brought into the basins largely by underground circulation, and the salts reach the surface by capillary action. The saline concentration is mainly superficial. The dry playas, with surfaces of hard smooth sun-baked clay have no saline concentration. They are formed in non-water-tight basins where the water table is below the depth of capillary rise.

Some investigation of the desert playas has already been made in connection with the quest for potash. According to Mr. Foshag, "a critical study of the deposits would not only determine their possible importance as saline deposits, but also give much data upon the origin of the similar and perhaps much more important uplifted Tertiary lake beds which occur in the same general area" and which provide the chief source of the recent deposits.

Expeditions to the Gulf of California and the Islands West and South of Lower California. In 1921 the California Academy of Sciences sent a group of six representatives to study the fauna and flora of the islands in the Gulf and of localities on the adjacent mainland. Two representatives of the Museo Nacional of Mexico were commissioned to accompany the party. The expedition started from the port of Guaymas in April and, during the following three months, visited nearly all of the islands in the gulf and touched at many points along both coasts that are seldom reached by outsiders either from Mexico or abroad.

Reports from each group of scientists have been published. As an official publication of the Mexican government there has appeared a narrative of the expedition (Carlos López: Informe preliminar acerca de una expedición al Golfo de California, *Bol. Oficial Sec. de Agric. y Fomento*, Vol. 6, 1921, Nos. 9, 10, 11, and 12, pp. I–XXI). The American members of the expedition issued their reports including a "General Account" (Ser. 4, Vol. 12, 1923, No. 6) and technical papers in the *Proceedings of the California Academy of Sciences.*

Only a few of the islands were found to be inhabited either by whites or Indians. The Seri apparently use some of the islands, particularly the island of Tiburón lying just off the continental shore of Mexico, as hunting grounds though seemingly not for permanent residence. There is little to tempt anyone to live on these isolated bits of land or along these shores. In fact there is no water and little soil on many of the islands. A few pearl hunters are still seen, but that once important business is nearly at an end. At some of the small settlements along the coast fishing affords a meager living for part of the inhabitants. Distance from good markets prevents the development of this which would otherwise, perhaps, become an important industry. In a few places the extraction of salt from sea water constitutes a means of livelihood for a tiny colony. The only prosperous community encountered by the expedition, aside from the port of Guaymas on the eastern shore of the Gulf, was Santa Rosalia, where copper, mined in considerable quantities and smelted with coal brought on sailing ships, is exported from the artificially constructed harbor in sufficient amounts to form the basis of a comparatively thriving community of some ten thousand people. At the mouth of a few of the deep, narrow canyons that reach from the high interior of the peninsula to the west coast of the gulf, there is sufficient water, either surface or subterranean, to make possible attractive gardens and orchards of palms, figs, oranges, mangoes, and other tropical fruits; and in such spots the old Spanish towns of La Paz, Mulegé, and Loreto, founded long before Upper California was colonized, still drowse in the continuous heat that is supposed to have suggested the name for the peninsula when Cortés and his fellow discoverers first cruised along the shores of what at that time was thought to be an island.

In 1922, under the auspices of a "Committee on the Conservation of Marine Life of the Pacific" appointed by the Pacific Division of the American Association for the Advancement of Science and with the aid of several scientific societies and the National Government of Mexico, an expedition was undertaken to the islands off the west coast of Lower California. A general report of this expedition is contained in the *Proceedings of the California Academy of Sciences*, Ser. 4, Vol. 14, 1925, No. 12. A prime object was to secure data on the Guadalupe elephant seal, the Guadalupe fur seal, and the southern sea otter, all formerly abundant on the shores and islands of California and Lower California. While no examples of the two latter were found, the remnant of a herd of elephant seals was located and counted on Guadalupe Island, 150 miles off the mainland coast. As a result of the researches of the expedition, Mexico has declared Guadalupe Island a game preserve.

In 1925 the California Academy of Sciences organized an expedition to the Revillagigedo Islands. These are a group of four main islands, the largest of which, Socorro, lies some 260 miles west of south of Cape San Lucas. Guadalupe Island, the Tres Marias Islands, and the coast of Lower California were visited in addition to the Revillagigedo Islands. Although the islands visited are difficult of access, barren and unattractive to man, they were shown to be of great scientific interest. Plants and animal collections were made and geological and photographic studies carried out. Important topographic features, hitherto nameless, were named. The U. S. Geographic Board and the Government of Mexico have since approved these names. A general report of the expedition in narrative form appears in the *Proceedings of the California Academy of Sciences*, Vol. 15, 1926, No. 1.

George M. McBride

The Locust Plague in Mexico. The serious and general invasion of Mexico and her southern neighbors by locusts during the period 1923–1926 has attracted the attention of zoölogical workers throughout the western world. The state of Veracruz through the agency of the Comisión Científica Exploradora de la Plaga de la Langosta enlisted the services of Dr. Carlos C. Hoffmann who gives the results of his survey of the situation in *Memorias y Revista Soc. Científica "Antonio Alzate"* (Vol. 44, 1925, pp. 191–227).

The group of Acrididae to which the locust in question (*Schistocerca paranensis Burm.*) belongs is a very ancient and firmly established one in South and Central America. The particular species is distributed geographically from about latitude 44° S. to latitude 25° N. It is a truly tropical species, very sensitive to changes in environment and showing definite moisture requirements for its survival. It is not known to invade the United States.

As in the case of the migratory locusts of the old world, *Schistocerca paranensis* has two distinct forms. One of these is primitive and non-migratory, and the other represents the well known pest, the migratory form. In its permanent habitats the non-migratory form does not originate migrating swarms, as these regions consist of "biologically balanced areas." It has been shown that the migratory form of *paranensis* requires a loose, moist soil for successful oviposition and multiplication. This is believed to be furnished in the silt deposited by the periodical inundation of river banks and benches on the edges of the permanent habitats when conditions favorable to multiplication have continued for some time. The subsequent desiccation, or perhaps the excessive locust population, of such inundated areas stimulates migration. Upon reaching cultivated lands the migrants find soils and conditions ideal for rapid multiplication, thus originating plagues. In Veracruz these begin in the tropical lowlands and progress from southeast to northwest, gradually approaching the mountainous highlands where the outbreaks eventually die out. In the meantime, however, there may be numerous return flights of adults from the highlands to lower elevations. This is in marked contrast with the habits of the species in the Argentine where enormous flights over wide areas from north to south and return are the rule. The marked vertical variation in climate obtaining in Veracruz has facilitated the environmental studies.

In the temperate sections there are but two generations annually, but there may be four in tropical areas. The latitudinal limit of the movements of the swarms of young hoppers in Veracruz is 19° N.; the altitudinal, 1600 meters above sea level. The tropical part of the state forms the true center of the plagues, which are believed to originate in Guatemala; at least they enter Mexico from that country either from the Lake Peten region or to the southward thereof. The author believes the "Peten zone" to be of great importance and that a thorough study of this and similar regions would do much to solve the problem of locust invasion and perhaps permit the discovery of effective control measures. In this work the coöperation of neighboring republics would be a necessary concomitant.

It is apparent, in view of the present comprehensive studies of Dr. Hoffmann and his colleagues and those recently made in the Argentine and Bolivia, that the fundamental data for a complete understanding of the migratory locust problem in Central and South America may soon be available and give hope of the practical solution of this long-standing and important problem.

W. R. Walton

SOUTH AMERICA

The Rains and Floods of La Libertad, Peru, in 1925. Reference has been made in preceding numbers of the *Geographical Review* to the abnormal rains and resulting damage on the Peruvian coast in 1925, and one phase of destruction is illustrated in this number by Major Holstein who writes of the ancient ruins of Chan-Chan near Trujillo. A fuller discussion of the effects of rains and floods in the department La Libertad, of which Trujillo is capital, is given by Señor Jorge M. Zegarra, chief of the Technical Commission of Irrigation (Las lluvias y avenidas extraordinarias del verano de 1925 y su influencia sobre la agricultura del departamento de La Libertad, Lima, 1926).

Normally the rains of the north Peruvian coast are limited to a few showers of short duration generally falling during the summer months, January–April. Thus the average annual rainfall of Trujillo for 1918–1924 (Hacienda Herederos, a short distance east of the city) is given as 4 millimeters; for a station in the lower Chicama valley 22 millimeters is the average for a five-year period. In the Sierra rains are heavier, and the annual floods in the streams provide water for irrigation (see Fig. 4, p. 39). The upper Chicama basin is credited with a yearly rainfall of about 600 millimeters. In the summer of 1925 Trujillo had some 400 millimeters; a station in the upper Chicama valley 1400 millimeters. The most serious damage was done by the floods. The four major streams of the department, the Jequetepeque, Chicama, Moche, and Virú, have average maximum discharges of 200–250, 350, 150, and 75 cubic meters a second respectively. All gauging stations were swept away by the floods of 1925, but estimates place the discharges of these four streams at 480, 1200, 800, and 800 cubic meters a second respectively. The coastal quebradas normally dry carried much water; the Rio Seco of Huanchaco, for instance, emptying directly into the sea, was discharging at the rate of 300 cubic meters a second on March 24.

The town of Chicama was practically destroyed; Virú was partially destroyed and communications seriously disrupted. Thanks to early preventive measures Trujillo escaped the menace of the Moche. The most important question for the inhabitants of the region, however, was the effect on agriculture. The Department has some 45,000 hectares (over 110,000 acres) under cultivation in the four valleys;

over half the total in the Chicama valley, nearly one-third in Jequetepeque. The sugar and rice crops of Chicama are valued at over 2,500,000 Peruvian pounds, the rice and cotton of Jequetepeque at nearly 500,000 Peruvian pounds. The floods broke down irrigation channels and covered fields with sand and gravel. The sucrose content of the sugar cane is also said to have been unfavorably affected. On the other hand the land benefited by the exceptional watering. Two sugar estates have already reported larger yield; and in particular great benefit, which will redress the losses from the drought of 1923–1924, is expected for subsequent rice crops in Jequetepeque. Señor Zegarra thinks the balance is favorable to agriculture.

A Remarkable Population Forecast in the Argentine. In 1872 Diego G. de la Fuente, reporting the results of the First Argentine census, that of 1869, estimated the population of the Republic for the ensuing fifty years with an accuracy as astonishing as the wildness of our own census estimates.

He had gathered up all the earlier *estimates* of Argentine population, the values for the years 1809 decennially to 1859 being respectively 406, 527, 634, 768, 935, and 1304 thousands of persons. His census for 1869 gave 1,736,923. He calculated from these values decennial percentages of increase of 30, 20, 21, 22, 39, and 33, only the last two being free of the incubus of the tyrant Rosas. Then he turned to the censuses of the United States from 1790 to 1860, noting increases of 35.02, 36.45, 33.13, 33.49, 32.67, 35.87, and 35.57 per cent, an average of 34.6 per cent. From his opinion of the capacity of his country to maintain population and from these two histories of the past he judged that the population of the republic was going to increase for many years at the rate of 36 per cent a decade. That gave him for the dates 1879 to 1919 respective values of 2464, 3444, 4778, 6591, and 9057 thousand persons.

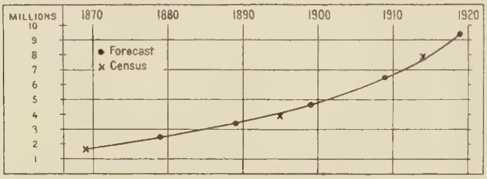

FIG. 1—Estimated growth of population in the Argentine Republic, shown by a curve (Primer censo de la República Argentina verificado en los dias 15, 16, 17 de Setiembre de 1869, Buenos Aires, 1872, p. xxii) compared with actual census values, shown by crosses.

As a matter of fact the figures of the two censuses taken since his day fall almost exactly on the figures of his estimates—in 1895, 3,954,911; in 1914, 7,885,237—as is seen on the accompanying diagram. Either he was lucky or his method is a sound one.

MARK JEFFERSON

EUROPE

Is Britain Overpopulated? Among the findings of the Royal Commission on the Coal Industry (1925) (Report, Vol. 1, London, 1926) is one of great interest to students of population problems. The conclusion is drawn that the coal industry is overmanned and "is too large in size for the requirements it has to fulfill" (p. 230). Even if labor is transferred from low grade to high grade collieries, even if wages are lowered and a still lower standard of living enforced, there remains the question as to whether the coal business can continue to maintain its present proportions.

In a spirited article on the British population problem as a whole, Professor Thompson draws some alarming conclusions (W. S. Thompson: "Britain's Population Problem as Seen by an American," *Econ. Journ.*, Vol. 36, 1926, pp. 177–191). He believes that the general falling off in purchases from Great Britain since the war is not merely a post-war episode or a passing phase of the business cycle but represents a new alignment of the world's industrial power in which Great Britain will continue to suffer unless her industrial population is in part turned out upon the land. By an analysis of the several parts of the British Empire from the industrial standpoint he finds such a growth of local or regional industries as to threaten continued decline of imports from the mother country. Statistics bearing on the point are given from Australia, Canada, and South Africa. Outside the Empire the situation is the same. Only in South America does the field still look favorable.

To Russia, Britain exports only one third as much as in pre-war years. British exports to Germany in the five years 1919–1923 were less than one quarter of what they were in 1909–1913. The industrialization of India and China, though only begun and even though moderate in its scope, still represents a serious invasion. By contrast, the exports of the United States and of Japan have vastly increased with the increase of their merchant fleets, and Canada and Australia have taken an independent attitude toward the development of their foreign trade. Professor Thompson does not see in the development of tropical peoples much relief for Britain, because their capacity to absorb imports is very small and tropical agriculture as a whole does not lend itself to extensive machine methods of tilling. He points to the nine per cent of people in Britain engaged in agriculture and believes this to be dangerously small or that the proportion engaged in industry and commerce is dangerously large. He concludes with a special warning to the United States to learn from the present plight of Britain and study the means of avoiding it by promoting agriculture as the basic condition of a balanced national life.

A New Rainfall Map of the Iberian Peninsula. A detailed map of precipitation in the Iberian Peninsula for the five years 1916 to 1920 has been prepared by Señor Pedro M. González Quijano (La lluvia en la Península Ibérica durante el quinquenio de 1916–20, *Rev. de Obras Públicas*, No. 2428, May, 1925). There are 961 stations of reference, all with more than a year of record, while 376 have the five years complete, except perhaps for a month or two. Short-period series have been reduced to the mean by multiplying by a factor obtained from a group of stations near, on the assumption of proportionate rainfall. Some stations whose values came out discordant when thus reduced have been rejected.

An interesting key map shows the distribution of stations by the drawing of circles of ten-kilometers radius around each. It would have been well, in addition, to have put a distinct dot at each point of observation. The striking feature of the distribution is the paucity of Portuguese measurements. The east and south of Spain seem fairly well provided with stations, as if people took most interest in rainfall where they lacked it, for that part of the peninsula is distinctly semi-arid.

The defect of the map is the shortness of the record on which it is based: the five years might, of course, fall in a wet period or a dry period. To check up on this, Quijano has listed the normal values of annual rainfall for 36 older stations alongside the means for this pentad, with the quite astonishing result that exactly half the stations have "normal" means larger than the pentad means, the other half smaller! More than that, the mean of the pentad values is in round numbers 613 millimeters, of the "normal" values 618. Individual values, it is true, have differences that seem more credible; Caceres, 468 pentad, 751 normal; Murcia, 280 and 537; Orense, 916 and 700; Santiago, 1438 and 1655; and Santander, 1189 and 839. Quijano draws from this comparison what he is careful to call the "simple impression" that the decade was a rather dry one.

Isohyetals are drawn for every 100 millimeters. We reproduce in Figure 1 the lines for 500, 1000, and 2000, giving side by side the same lines from Reger's map of 1903, "Regenkarte von Europa" (*Petermanns Mitt.*, Vol. 49, 1903). It ought to be noted that the values Quijano gives in his table of comparisons for the 36 points do not agree very well with his isohyetal lines: there are several instances of dis-

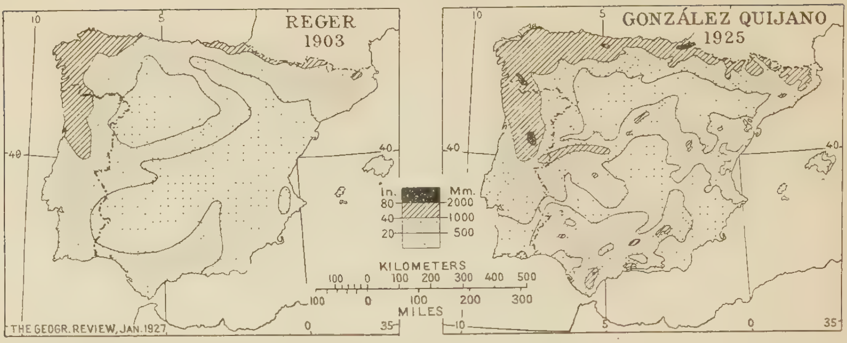

FIG. 1—A new rainfall map of the Iberian Peninsula compared with an earlier interpretation. Scale of maps approximately 1: 23,500,000.

crepancies of 50 millimeters or more. The differences do not appear to result from misregister of the red isohyetal lines on the black base, for they all come nicely to the coast. Apparently the lines are drawn without the precision that should accompany so minute a grading of rainfall values.

In general the new map gives Spain and Portugal more rain than appeared on Reger's map. Quijano thinks the whole peninsula has an average of 680 to 700 millimeters: Spain alone would have 649 and Portugal 837—a little more than Angot estimates for France on more complete data. But the form of the distribution is little changed, heavy rains in the north and northwest, a belt of 500-millimeter rain across the peninsula from southwest to northeast, with pockets of scanty rainfall on either side. The northern pocket of lighter rainfall on Reger's map was an interior area, mostly to the northwest of Madrid. Now this is extended almost across the peninsula to Tarragona. The southern area of drought formerly was represented as reaching to the Mediterranean almost from Málaga to Barcelona, with a slight interruption along the eastern end of the Sierra Morena. It is now interrupted in a number of places, and the mountains of the south show four areas with over a meter of rain. As is always the case with increasing data the isohyetals have become much more intricate in their pattern than we were wont to draw them. But a five-year period is very short.

MARK JEFFERSON

AFRICA

Changes in Egyptian Agriculture. The national revenue of Egypt is estimated at £E300,000,000 a year. About half this sum is derived from landed property, of which over two-thirds is from crops. The proverbial fertility of her soil is still the chief asset of the country. It has been maintained through centuries by the nice adjustment of cultivation to physical conditions. But of recent years methods have changed: what of the ancient fertility? Some crops have shown a decline in yield in the last two decades. The problem is discussed by Victor M. Mosséri, technical adviser to the Royal Agricultural Society of Egypt, in the *Compte Rendu* of the International Geographical Congress, held at Cairo, 1925 (La fertilité de l'Égypte, Vol. 4, pp. 135-168). An English summary appears in the *International Review of the Science and Practice of Agriculture*, January–March, 1926). In earlier studies M. Mosséri had demonstrated that one of the chief factors in the renewal of the Egyptian soil was the annual period of fallowing, the *charaqi*, from May to September. During the hot, dry summer soil temperatures of 55°–70° C. are experienced. The tenuous soil, with its high percentage of colloidal clay, shrinks and cracks. Cracks, in fact, may occupy as much as 35 per cent of the surface. Among the beneficial results of the cracking process are a sterilization of the soil from weeds and parasites, removal of excess salts, aëration, increased permeability and porosity—in other words, the effect secured by careful cultivation. After the *charaqi* the basins formerly were inundated from the Nile flood waters and later sown to winter crops.

Today perennial irrigation has replaced the old basin system over four-fifths of the cultivated area. Summer crops can now be grown. A new biennial rotation has sprung up in which the *charaqi* period has been greatly curtailed, in particular by what M. Mosséri calls the "excessive expansion of cotton growing."

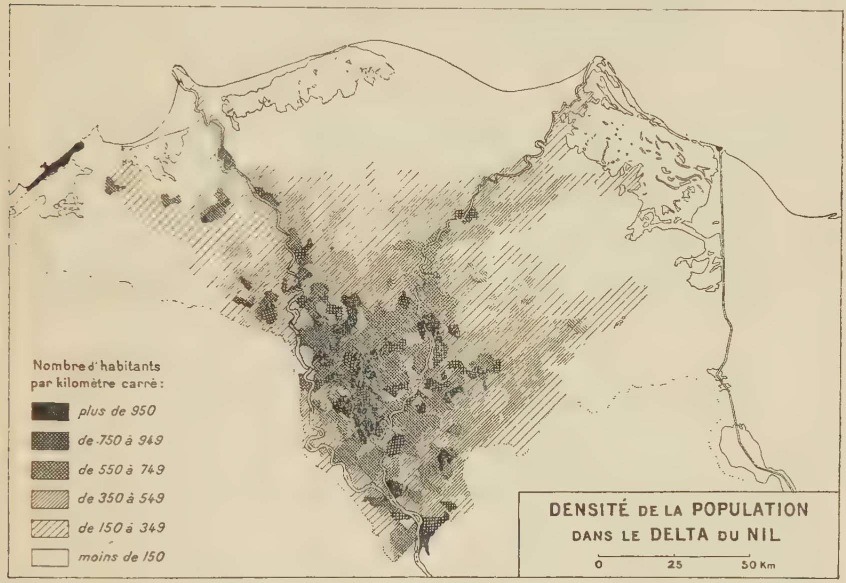

FIG. 1—Map showing the high density of population in the Nile Delta, reproduced by permission from the map by V. M. Mosséri in the *Annales de Géographie*, Vol. 25, 1926, p. 167.

The recent changes in the agricultural economy of the country are discussed by M. Demangeon in the *Annales de Géographie* for March, 1926. By the side of the traditional harvests are vast acreages of other crops—bersim, cotton, maize. Bersim (Alexandrine clover), a forage and fertilizing plant, has assumed great importance. It occupies more than a fifth of the cultivated area, as much as cotton, more than wheat, a little less than maize. Sugar cane occupies less than one per cent of the area; but the conditions under which it has been established, the modern equipment and processes used, present an interesting contrast with the primitive agriculture existing side by side.

The new crops, entailing more work, more implements, the use of commercial fertilizer, new needs of water, raise the question of the laborer: has the *fellah* too changed? Not as much as one might imagine, says M. Demangeon, and the prime reason lies in the very great density of population. The *fellahin* cling to the soil: the majority now are peasant proprietors, and the land tends towards minute subdivision. In 1896 there were 767,000 landed proprietors, whose holdings averaged 6 feddans (a feddan is a little more than an acre); in 1924 there were 1,972,365 proprietors, whose holdings averaged 2.9 feddans.

One change in the conditions of rural life to which M. Demangeon calls special attention is the movement from the crowded village agglomeration to the isolated farm, *ezbeh*, a movement encouraged by the new methods of agriculture and similar to the movements towards dispersion in various agricultural lands of western Europe.

ASIA

The Bakhtiari Tribes of Southern Persia. The interesting mountain tribes of southern Persia, the Bakhtiaris, formed the subject of a recent lecture by Sir Arnold T. Wilson (*Journ. Central Asian Soc.*, Vol. 13, 1926, pp. 205–225). The lecture was illustrated by the remarkable film "Grass" which Fellows of the American Geographical Society will recall was shown by Mr. Merian Cooper at the Society's meeting in January, 1925 (see also Mr. Cooper's book "Grass," New York and London, 1925).

Many theories as to the origin of the Bakhtiaris have been formulated. Recent research into tribal legend and tradition suggests that under this collective name are grouped refugee tribes from a half dozen races now absorbed into the original Iranian stock. Today two main divisions of the tribes are recognized, the Haft Lang and Chahar Lang. The majority of the Haft Lang are nomadic and in the course of their seasonal migrations cover all the central part of the tribal territory, wintering in the low hills and valleys fronting the plains of Arabistan, summering in the lofty central ranges and hill plains on the border of the central Iranian plateau. They also practice agriculture to some extent. Many tribes raise two crops of grain during the year. On the uplands the grain is sown in the autumn and reaped in the succeeding summer. In the lowlands the winter planting is harvested by members of the tribes left behind at the spring exodus—an inverse, one might say, of the practice in transhumance.

The Chahar Lang, now numerically inferior, occupy the southeastern part of the tribal territory where they are more or less sedentary and the northern and western frontiers where they are nomadic.

On the Palisade in Manchuria. While most of the contributions that have so far appeared in the *Japanese Journal of Geology and Geography* (National Research Council of Japan) are geological, note may be made of a paper under the above title by Professor Hiroshi Satô of the Tokyo University of Commerce (Vol. 3, 1924, No. 3–4, pp. 167–178). The Palisade is an extension of that most famous artificial boundary, the Great Wall of China (see map in F. G. Clapp: Along and Across the Great Wall of China, *Geogr. Rev.*, Vol. 9, 1920, pp. 221–249). From better-preserved portions of the western section some idea may be gained of the construction, which was apparently a dike topped by a stockade of willows and moated on the outer side. It was built in the seventeenth century as a defense and a protection for colonists in the extreme northeastern part of the Manchu domain. The western section of the Palisade, 500 miles in length, starts at the Great Wall 15 miles north of Shanhaikwan and runs northeast terminating beyond the Sungari River north of Kirin. The eastern branch, 260 miles in length, starts northeast of Kaiyüan, runs southeast along the divide between the Liao and Sungari, then southwest along the western edge of the Yalu basin. The purpose of this branch was to demarcate the Imperial hunting grounds. In addition to the Palisade we have here on the right bank of the Yalu one of the classic examples of the waste-land frontier. In 1627, nearly 6000 square miles were set aside as a "no man's land" in which settlement was prohibited until as late as 1867, when it was opened by the Peking government to settlers from Shantung.

Today little survives of either feature. Of the eastern branch of the Palisade there is scarcely a vestige save some old village names. One souvenir remains, however, in some of the towns of the region, which had their origin as boundary markets. Such is Changchun, west of Kirin. Thither comes a great part of the staples of Kirin and Amur provinces. From autumn to spring Mongolian products arrive by camel train, and fairs for grains and animals are held several times a year. Changchun now has important rail connections and has grown rapidly of late years. Like other towns of the region it has almost entirely lost its former Mongolian character.

POLAR REGIONS

FIG. 1

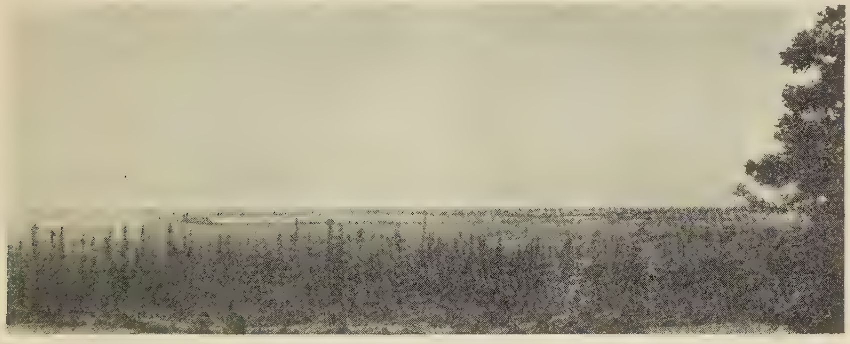

FIG. 2

FIG. 1—The midnight sun at Selawik, Alaska, in June, at 20-minute intervals. Photograph by Mr. Sylvester Chance.

FIG. 2—The midday sun at Noorvik, Alaska, December 21, at 15-minute intervals. Photograph by Miss Alice Riner.

Refraction and Daylight in the Arctic. The accompanying photographs give a striking demonstration of the fact that it cannot be true, even in an approximate sense, that we have six months day and six months night at the North Pole. The photograph, Figure 1, is taken at Selawik, Alaska, near Kotzebue Sound and exactly on the Arctic Circle. It is taken practically from sea level, but the sun is obscured by a range of hills, the Kobuk Mountains, about 3000 feet high. The photograph shows plainly enough that the hills are higher than would correspond to a full diameter of the sun, and they make, therefore, a demonstration of what we know from theory, that refraction keeps the sun almost a degree above the horizon at midnight in summer and more than a degree above the horizon at midday in winter.

The photograph, Figure 2, is of the midday sun, taken on December 21, 1923, at Noorvik some fifteen miles north of Lake Selawik.

V. STEFANSSON

THE OCEANS

The German Atlantic Expedition. The South Atlantic and neighboring Antarctic was the field chosen for the first important German oceanographic expedition since the war. Under the scientific leadership of Dr. Alfred Merz of the Oceanographic Institute of the University of Berlin, the *Meteor*—a converted man-of-war—left Wilhelmshaven April 16, 1925, with a complement of experienced oceanographers aboard, the plan calling for approximately two years of intensive oceanographic investigations.

The program of the expedition is outlined by Dr. Merz in a paper entitled "Die Deutsche Atlantische Expedition auf dem Vermessungs- und Forschungsschiff 'Meteor'." (*Sitzungsber. Preuss. Akad. der Wiss., Phys.-Math. Klasse*, 1925, pp. 562–586). The principal question to be studied is the circulation of the water, both horizontal and vertical. This problem will be attacked directly and indirectly—directly by measuring the current at definite points in the ocean and indirectly by the application of the theoretical dynamic principles of Mohn and Bjerknes to the distribution of density and temperature. All factors entering into this question are to be studied quantitatively—density, temperature, bottom relief, rainfall, evaporation, and related chemical, physical, and geological features. For this purpose the expedition is fitted out with a full complement of modern oceanographic apparatus including four different types of echo or sonic sounding apparatus.

In his paper Dr. Merz discusses the present state of knowledge of the oceanography of the South Atlantic, directing attention to the fact that this knowledge is almost wholly of a qualitative nature. It is the aim of this expedition to derive quantitative data of a precise nature. To carry out the program outlined, fourteen cross sections or profiles between Africa and South America are planned with a number of stations across each of these profiles.

Early in June the systematic observations on the first of these profiles was begun, but after five stations had been occupied the work was interrupted by the illness of Dr. Merz. He was taken to Buenos Aires, and here on August 16, 1925, he died. The leadership of the expedition now devolved on Captain F. Spiess, Commander of the *Meteor*, and the work continued in accordance with the original program.

The first report on the progress of the work is given in two groups of eight papers each in the *Zeitschrift der Gesellschaft für Erdkunde zu Berlin* (1926, pp. 1–77 and 209–274). These comprise preliminary reports on the results of the first three profiles and of the fourth and fifth profiles respectively, and consist of the report of the leader and reports on the oceanographic, biologic, geologic, acoustic, chemical, and meteorological investigations.

H. A. MARMER

WORLD AS A WHOLE AND LARGER PARTS

Government Intervention in the Export Trade of New Zealand and South Africa. New Zealand is aptly characterized as an "outlying farm or supply station for the Mother Country." In 1925 her export trade amounted to £55,200,000 the bulk of which represented pastoral products, chiefly wool, butter and cheese, and frozen meat. The total foreign trade for that year was £107,700,000. The per capita trade, like that of Great Britain, is abnormally large. With her prosperity singularly dependent on her exports New Zealand suffers the handicap of extreme remoteness. Her chief customer, Great Britain—taking 80 per cent of exports in 1924, is at the maximum distance. New Zealand has no shipping lines of her own, and there are particular difficulties in adapting to market fluctuations the primary production in which she is engaged. In the period of depression following the post-war boom she resorted to state intervention. The Meat Export Control Act was passed in 1922;

dairy produce and the minor fruit, honey, and kauri-gum industries followed suit. Shipment, freight, grading, insurance, and handling of the commodities are regulated, and the Dairy Board is assuming control of the selling end. The Meat and Dairy Export Control Boards between them govern nearly 95 per cent of the export trade (*The Round Table*, No. 64, 1926, pp. 877–888).

Fruit export from South Africa is a new trade developed in a generation in a comparatively new country. Climatically the African subcontinent is admirably suited to the growth of fruit in great variety; no less than 25 different kinds are now produced on a commercial scale. Home consumption is large, especially on the mining fields: and, with the exception of sugar, no exports in the last ten to fifteen years show relatively a growth anywhere near comparable. In 1923 fresh and dried fruit exports amounted to over three-quarters of a million sterling.

Fruits are classed as deciduous, chiefly pears, grapes, peaches, and plums, for which the season is from December–January to April–May and citrus, chiefly oranges, for which the season is May–June to September–October. In 1922–1923 over a million cases of deciduous fruits and 900,000 cases of citrus fruits were shipped from the Union. The methods of marketing this highly perishable product bear some resemblance to the coöperative measures adopted in California and Florida, but there are fundamental differences in the problem. The American commodity is mainly sent by rail from compact growing areas: the South African commodity is collected from a subcontinent into four outlets to be shipped thousands of miles by water. Government intervention was early sought: the first act of control being passed in 1914. In 1921 the Fruit-Growers' Coöperative Exchange was incorporated. By the Fruit Export Control Act of 1925 the export of fruit from the Union can be effected only through the Fruit Growers' Exchange, except for consumption in Rhodesia, the Protectorates, and the Belgian Congo. An amendment restricts shipment through Lorenço Marques via Komatipoort (Transvaal). Internal arrangements in the industry are now said to be in a satisfactory state; the outstanding problem is the provision of shipping accommodation for the anticipated export of six million cases of citrus fruit by 1930 (*The Round Table*, No. 62, 1926, pp. 417–426).

Geodesy and Cartography in Soviet Russia. The U. S. Coast and Geodetic Survey has received a communication from Dr. Jules Schokalsky, President of the Russian Geographical Society, telling of the first Conference of Geodesy, Topography, and Cartography of the Union of Soviet Socialist Republics, of which he also was president. The conference was held in Moscow in April, 1926.

The immediate result of the Moscow conference was the adoption of a set of resolutions in regard to the various surveying and mapping problems of the country, and it is hoped that there will follow the collection of accurate geodetic data, which in turn will be followed by scientific investigations, especially in regard to deflections of the vertical and values of gravity. It may be interesting to note that there has been great activity in Russia in recent years in connection with magnetic surveys, for it has been found that the magnetic needle can be used in searching for buried minerals having magnetic properties. A summary of the more outstanding features of the resolutions is given below.

It was decided that the existing scheme of triangulation is sufficiently precise to determine the elements of the terrestrial spheroid provided additional bases are measured and additional rounds of angles are taken on signals which are excessively high. The Bessel spheroid has already been used on much of the computation work and has been retained for the immediate future instead of the Hayford spheroid adopted as standard at the Madrid meeting of the International Union of Geodesy and Geophysics in 1924. It is intended to connect up the existing independent triangulations, especial attention being given to that along the 41st meridian in view of its great length and consequent importance as a factor in the determination of the spheroid. To secure connection between Russian and foreign geodetic operations a scheme involving the coöperation of the Prussian Geodetic Institute was suggested.

Connections by precise leveling between the White, Black, and Baltic seas and the Pacific Ocean are to be completed. The zero of the Cronstadt gauge will continue to be taken as the initial datum point for heights throughout the country. It is proposed to construct two fundamental bench marks near Cronstadt on stable geological formations and to redetermine at fixed intervals their relation to the Cronstadt zero.

An urgent need is determination of the difference in longitude between Greenwich and Pulkovo. All available data will be examined to arrive at the most probable value. A longitude bureau attached to the Pulkovo observatory is proposed to work in close coöperation with the geodetic committee, collecting data and determining the differences of longitude between strategic points in the first-order triangulation both from the results of the trigonometrical operations and by absolute methods involving the use of wireless time signals. In connection with these latter, corrections for the time signals sent out by Pulkovo would be published.

It was resolved that the National Commissariats of Agriculture of the various republics in Soviet Russia should undertake their own local cadastral operations and develop detailed triangulation but that, in order that this work might be accomplished with sufficient precision, secondary triangulation and leveling should be undertaken by the state, thereby controlling all topographic work by geodetic operations. Emphasis was laid on the value of phototopography and aerial topography undertaken in conjunction with other surveying operations, and the need for instrumental research in this connection and for the manufacture in Russia of photographic supplies was stressed.

In considering the question of the standardization of map scales, it was decided to use in the future only scales suitable for use with the metric system. Those chosen were 1: 5,000; 1: 10,000; 1: 25,000; 1: 50,000; 1: 100,000; 1: 200,000; 1: 500,000; and 1: 1,000,000. Old maps on other scales should be kept up to date until replaced by the new ones. However, this standardization should not apply to hydrographic charts.

Participation by the Soviet in the International Millionth Map was recommended. The working out of a system of transliterating Russian geographic names into the Roman alphabet is being entrusted to the Russian Geographical Society.

The need for hypsometric maps on small scales and for magnetic charts was emphasized, as also the construction in Russia of geodetic and geophysical apparatus. Finally, it was resolved that the special map requirements of the geologist, the geomorphologist, and the geographer must be considered in formulating all surveying instructions.

PHYSICAL GEOGRAPHY

The Prediction of Tidal Waves. The so-called "tidal wave" which at times devastates coastal regions is in no way related to the tides. Occasionally it is the result of a severe storm, but generally it is brought about by seaquakes. In spite of its being a misnomer, the appellation has become firmly established and is more readily understood than the technically correct designation of seismic sea wave. Because of the suddenness with which it overwhelms the coast, the possibility of predicting the occurrence of a tidal wave is of great importance even if such prediction can be made only a few hours in advance of its occurrence.

Seismic disturbances are transmitted more rapidly through the solid earth than through the waters of the sea. For regions subject to tidal waves, therefore, the preliminary seismic waves recorded by a seismograph serve as an advance notice of the possible coming of a tidal wave. Such a method of prediction for Hawaiian waters is outlined by R. H. Finch in a paper entitled "On the Prediction of Tidal Waves" (*Proc. Pan-Pacific Science Congress, Australia, 1923*, Vol. 2, pp. 1366–1368, Melbourne). Taking advantage of the fact that the time in minutes required by the first preliminary waves of a quake to reach a given point through the earth is very nearly the same as the time in hours required by the seismic sea wave, a table has been prepared showing the distance from Hawaii of most of the earthquake regions in the Pacific and the time required for a seismic sea wave from each region.

The author notes that it is usually impossible to make positive predictions of tidal waves from the seismograph records of but one station, for, even if the distance and general direction of the seismic disturbance are known, the distribution of land is such that there is nearly always a doubt as to whether the quake occurred on land or under the sea. It may be added, too, that apparently it is only the seaquake accompanied by subsidence of an area of the ocean floor that gives rise to tidal waves. But from the seismogram it is not yet possible to determine when such subsidence takes place, and therefore the seismic disturbances recorded by a seismograph indicate only the possibility of a tidal wave.

H. A. MARMER

GEOGRAPHICAL NEWS

Scottish National Memorial to David Livingstone. A movement is under way to establish a memorial to David Livingstone in his early home at Blantyre on the Clyde near Glasgow. It is proposed to purchase his birthplace, to put it into repair, and to endow it as a museum for available Livingstone relics and for other exhibits indicating the vast development in Africa subsequent to the great explorer's discoveries.

In connection it is of interest to recall President Daly's introductory remarks at the Livingstone Memorial Meeting of the American Geographical Society held on April 23, 1874. "The connection of Dr. Livingstone with the Society extends almost to the period when he commenced his career as an explorer. His name has been the longest upon our list of honorary members. . . . We had hoped . . . that we would have had the opportunity, upon some public occasion, of expressing to him our appreciation and that of the American people of what he had done in extending the boundaries of human knowledge, and in the great cause of humanity."

The committee in charge of the memorial appeals for a sum of £12,000. Subscriptions should be sent to the Hon. Treasurer, Mr. James MacGregor Hart, at 142 St. Vincent Street, Glasgow.

GEOGRAPHICAL REVIEWS

Ocean Studies

James Johnstone. **A Study of the Oceans.** viii and 215 pp.; maps, diagrs., bibliogr., index. Longmans, Green & Co., New York; Edward Arnold Co., London, 1926. 9 x 6 inches.

Franz Graf von Larisch-Moennich. **Sturmsee und Brandung.** x and 186 pp.; maps, diagrs., ills., bibliogr., index. (Monographien zur Erdkunde, No. 33). Velhagen & Klasing, Leipzig, 1925. 10 x 7 inches.

G. Clerc-Rampal. **La mer: La mer dans la nature, la mer et l'homme.** viii and 303 pp.; maps, diagrs., ills. Librarie Larousse, Paris, n.d. 13 x 9½ inches.

Edward H. Smith. **A Practical Method for Determining Ocean Currents.** vi and 50 pp.; diagrs. *U. S. Coast Guard Bull. No. 14.* Washington, D. C., 1924. 9 x 6 inches.

Gerhard Schott. **Geographie des Atlantischen Ozeans.** 2nd edit. xvi and 368 pp.; maps, diagrs., ills., bibliogrs., index. C. Boysen, Hamburg, 1926. 11 x 8 inches.

The domain of oceanography is so broad and covers so great a variety of matters more or less intimately related that various modes of approach, groupings of topics and methods of treatment are possible in ocean studies. Treatises or textbooks of oceanography are obliged to leave all but the more formal content of the subject outside their ken. As a consequence, interesting and illuminating collateral matters—for example historical background, interplay of economic and political motives in the advancement of oceanographic exploration—are left outside the scope of what is ordinarily presented as oceanography.

It is some of these neglected aspects of oceanography that Dr. Johnstone discusses in "A Study of the Oceans." This may be regarded as a companion volume to his "An Introduction to Oceanography" (reviewed in *Geogr. Rev.*, Vol. 15, 1925, pp. 173–174) in which a formal introduction to oceanography was presented. Properly to orient the reader, Dr. Johnstone devotes the first chapter of the present volume to a brief summary of the geological history of the ocean, in which the various hypotheses of the origin of the earth, age and permanence of the ocean, the origin of the continents and of the great earth features are discussed. The two following chapters deal with the classical geography of the ocean and with the crossing of the ocean in their historical setting. The next chapter takes up the circumpolar regions, and here the dramatic stories of the quest for the Northwest Passage and of the attainment of the North and South Poles are related. This in turn is followed by chapters on the Atlantic, Pacific, and Indian Oceans in which, in addition to the physical features usually dealt with, such matters as human races, prehistoric civilizations, cycles of civilization, and the lost Atlantis are discussed.

Dr. Johnstone in this volume draws on a number of specialized sciences—astronomy, anthropology, geology, history. It is obvious, therefore, that many controversial questions must be dealt with in a summary manner. Despite this and despite, too, the wide range of matters covered, the volume rarely becomes merely encyclopedic; on the contrary, it is very readable, the various matters touched on focusing always on the oceanic question under discussion. The short bibliography, however, entitled "Suggestions for Further Reading" might well have included other than British publications, especially since no mention is made of the fact of such limitation.

In "Sturmsee und Brandung" Count Larisch deals with a single aspect of the ocean, the movement of the sea in response to the play of wind and weather. This is a subject beset with many difficult questions which frequently are discussed by means of mathematical formulae. In the present volume, however, the author sedulously avoids formal mathematics, having in mind the general geographic public rather than the specialist.

The subject matter is divided into three parts, the first of which, comprising about one-third of the volume, discusses the relations of wave to wind and the form of waves. The second part, constituting about half the volume, deals with the observed wave movements in the various oceans and seas. The author discusses the meteorological conditions and seasonal variations in the different oceans and the response in the movement of the waters. The third part is devoted to the varied phenomena of the surf caused by the breaking of the waves on different coasts and ends with a brief discussion of the work of the waves. The appended bibliography, comprising some thirty titles, lists the more important German, English, and French publications dealing with the subject matter.

Count Larisch discusses the subject of wave movement from the viewpoint of the observer and always with reference to its geographic setting. But he does more than this. He invests the subject with the feeling of the lover of the sea and brings to the reader something of the spirit of the restless waters in their varied moods—largely by means of the beautiful illustrations with which the text is embellished. One hundred and thirty-six photographs—all, it is of interest to note, the handiwork of the author—picture the sea in play and in anger throughout the world.

The scope of M. Clerc-Rampal's "La mer" is defined by its subtitle, the book being divided into two very nearly equal parts, the first dealing with "The Sea in Nature" and the second with "Sea and Man." Under the first heading the author begins at the very beginning of things and takes up in turn the generally discussed topics of the geography of the sea, the physical and chemical composition of its waters, its movements, oceanic life, ending with descriptions of the Museum of Oceanography at Monaco, the Oceanographic Institute at Paris, and several marine biological laboratories. In the second part, the author deals with the means employed in mastering the sea. Here are sections describing the development of the boat from the Egyptian galley to the modern leviathan and man-of-war, the sea fisheries with their varied activities, yachting, navigation, ports, and canals.

Obviously the volume is conceived on somewhat encyclopedic lines; and the topics throughout are handled descriptively. The various matters, however, are discussed without undue detail, and the interest is enhanced by a wealth of illustrations—nearly one thousand photographs, diagrams, and maps being included in the volume. One feature, however, cannot be commended. While no date of publication appears, there are references within the volume to dates as late as 1923, leading one to infer that the subject matter is treated in the light of knowledge at that time. But, as a matter of fact, this volume is in all essential respects exactly the same as the previous edition which, also without date of publication, appeared in 1913. The only differences are that here and there several sentences within a paragraph have been recast to permit the inclusion of a reference to "la guerre de 1914–1918" or to statistics of later date than 1913, and the substitution of several minor illustrations by others not too incongruous with Franco-German relations in 1923. The lack of an index in a work of this kind is also to be regretted.

In the foreword to "A Practical Method for Determining Ocean Currents" Lieutenant-Commander Smith states that it was compiled from a series of lecture notes made while the author was taking an advanced course in oceanography under Prof. Björn Helland-Hansen at the Geo-Physical Institute, Bergen, Norway. It is an exposition of the dynamic methods developed by the Scandinavian oceanographers—Bjerknes, Ekman, Sandstrom, Helland-Hansen, and others—for studying ocean currents. After a brief discussion of the forces involved in the production of currents, the author shows how from a knowledge of the temperature and salinity of the waters at various depths at several stations the velocity and direction of the current can be computed. The discussion is elucidated by examples taken from the observations of the International Ice Patrol. Within the compass of its fifty pages this publication gives the first adequate account in English of the procedure which must constitute the primary method in the study of oceanic circulation.

While dealing with the ocean from different points of view the four publications reviewed above have one character in common—it is with the ocean in general that they are concerned. In contrast, Dr. Schott's "Geographie des Atlantischen Ozeans" constitutes a regional geography of an area focusing in an ocean basin. Beginning with a historical chapter on the discovery of the regions facing the Atlantic, Schott then discusses the area, limits, and configuration of this ocean; the geological features of the region; the characteristics and movements of the waters; the climate and life of the ocean; and concludes with a chapter on "Man on the Atlantic Ocean." Natural regions in this area are stressed in connection with climate and with the physical characteristics of the waters.

The first edition of this admirable reference book appeared in 1912 (reviewed in *Bull. Amer. Geogr. Soc.*, Vol. 45, 1913, pp. 378–380), and in this second edition the high standard is maintained. The subject matter has been revised in the light of the most recent knowledge, the excellent bibliographies following each chapter have been brought up to date, certain sections have been completely recast, and several new ones added. Wegener's hypothesis appears in connection with the discussion of the origin of the Atlantic Ocean; the section on types of coasts and harbors is enlarged; a section on tides has been added; the chapter on life in the Atlantic Ocean has been completely rewritten and is from the pen of Dr. E. Hentschel; the last chapter, dealing with man's relations to the Atlantic, has been recast, and a section devoted to the geopolitical status of the Atlantic Ocean added.

Dating the entrance of the Atlantic on the political scene from the discovery of America, Schott epitomizes its changing status into five epochs which he denominates, respectively, the Portuguese-Spanish, the Dutch, the Franco-British, the British, and the British-American—its present status. In his opinion, however, this dual hegemony cannot continue permanently but is bound to be followed by a purely American (United States) epoch.

As a highway of commerce and intercourse the Atlantic is the principal ocean. Schott directs attention to the fact that it carries more than twice as much shipping as the Indian and Pacific Oceans combined. The oft repeated assertion that the Pacific is to supersede the Atlantic as the principal sea of commerce and of world events, Schott regards as unwarranted by the facts; and he says that "the Pacific Ocean suffers not merely from its size but also from the geographic fact that the countries on its eastern rim have their backs toward it, so to speak."

H. A. Marmer

Relations Between Canada and the United States

Robert Falconer. **The United States as a Neighbour from a Canadian Point of View.** viii and 259 pp.; map, index. University Press, Cambridge, 1925. 8s. 6d. 7 x 5½ inches.

There is drawn in this book an excellent sketch of the major problems that confronted Canada in the period of growth to nationhood. The early difficulties of the scattered provinces acting as separate units and not as an economic entity are forcefully presented. The small size of Canada in contrast to the wealth and power of the United States, the fact that she is to a large degree composed of two races with different religious creeds, and that the geographical disposition of the best country and the densest population makes it more natural for her separate units to trade region by region with the United States—all these difficulties have had to be overcome or partially offset first through confederation and the building of a transcontinental railway system, second, through the devotion and sustained faith of nationalists who looked upon the place of Canada within the British Empire as a much more important asset than union with the United States. Indeed, the growth and the persistence of loyalist sentiment in Canada is one of the least understood things in our country and is here intelligently presented as one of the most persistent qualities of political life in Canada.

One chapter deals with the boundary disputes between Canada and the United States and the manner in which they kept alive the bitterness that began with loyalist expulsions and confiscations during the Revolutionary War. Similarly, the fisheries and Bering fur-seal disputes have been sources of resentment. But the point is made that while all of these questions were frequently acute and Canada forced to agree to most treaties to her disadvantage, a war was never provoked by them and no permanent resentment has fastened itself upon these two neighbors. The line of the boundary is not so important now as the use of common resources upon it, as, for example, the waters of the Great Lakes for power and transportation and that of the Milk River for irrigation. The happy results of the work of the International Joint Commission are emphasized—twenty-five unanimous decisions since 1912 affecting interests of wide scope and economic importance. The power of the Commission is so great, as fixed by treaty, and the sentiment behind it in both countries so sincere that it has become one of the major international bodies of our time.

Among specific questions that receive fresh treatment are the growth to economic independence despite a closer and closer business relation to a much more powerful neighbor; the composition of the people of Canada and how it has been affected by streams of settlers from Canada to the United States in the East and from the United States to Canada in the Northwest; French-Canadian culture; and Canadian sentiments and opinions with respect to the social structure, the church, imperial policies, and the special conditions brought about by the World War.

RELATIONS BETWEEN EUROPE AND AMERICA IN THE AGRICULTURAL FIELD

EDWIN G. NOURSE. **American Agriculture and the European Market.** xvii and 333 pp.; diagrs., index. (Inst. of Economics, Investigations in Agric. Economics.) McGraw-Hill Book Co., Inc., New York and London, 1924. $2.50. 7½ x 5 inches.

Altogether admirable is the clear and forceful analysis here presented of the relations between European and American agriculture. Every geographer would do well to study the whole book closely, for he will find there available in compact form descriptions, statistics, and analyses of primary importance in world trade. It is made clear that the reference to 1914 as a normal year to which post-war conditions may safely be referred is erroneous and that a longer view must be taken in order to see not merely what *was* but what *was developing* in 1914 (p. 231).

After brief references to English colonial policies which meant the encouragement of the products of the southern colonies supplementary to British products and the discouragement by trade acts of the products of the northern colonies the course of American agriculture is traced through the period of the Civil War and down to 1914. Our relatively sparse population and rich and ample soil gave us an extraordinary position as the feeders of the dense populations of Europe which had an inferior soil. So western Europe became the workshop of the world, and the United States became its granary—and in addition its live-stock farm and cotton plantation. Whatever help this gave us, it was also true that European industrialism was helped by our cheap food. After the Civil War came a steady diminution of our free land and our own rapid industrialization. The result was that domestic consumption tended more and more to overtake home supply in the years just before the European War. Remarkably forceful are the statistics in showing the steadiness of this decline from 1900 onward. Europe turned in larger and larger measure to newer or less industrialized areas—Argentina, Canada, Russia, and Australia. The World War greatly stimulated our agricultural production. War prices tended to overcapitalization, and the end of the war meant the collapse of the European market.

The author traces in rapid style the course of events in one European country after the other, and his analysis clearly shows that relief for depressed American agriculture cannot come from European sources. We can best present his findings by quoting the concluding paragraph.

"We conclude that, as a prosperous Europe in the position of a heavy creditor of the United States was declining in importance as a market for our agricultural products at pre-war price levels, a less prosperous (not to say crippled) Europe, shorn of her credits here and our debtor on a tremendous scale, can not be expected to be a good market at present and prospectively higher levels of costs. Hence, agricultural exports may be expected to drop still further in 1924 and thereafter. For American agriculture to plan her future building on the foundation of an expected revival and growth of the European market would, therefore, mean building on quicksand."

THE GREAT REGIONS OF FRANCE

EMMANUEL DE MARTONNE. **Les grandes régions de la France: Description photographique avec notices géographiques.** With the collaboration of Paul Feyel and Maurice Teissier. **Région méditerranéenne.** 32 pp.; maps, ills. **Cévennes et Causses.** 31 pp.; maps, ills. Payot, Paris, 1925. 15 fr. each. 6 x 9½ inches.

The distinguished professor of physical geography at the Sorbonne here offers us two of a series of ten photographic albums each of which will treat one of the great provinces of France. That these little books are to be very different from the ordinary run of publications issued under the name "album" is quickly apparent. Instead of pictures of historic monuments, famous buildings and similar features, we find landscapes typical of the region under treatment, revealing how geological conditions and the forces of nature have determined the characteristic scenery of the country. Man's contributions to the landscapes are not ignored, however. There are illustrations of types of culture and views of cities, some of the best of the latter taken from airplanes. The illustrative value of the pictures is assured by the fact that many were taken by geographers, who selected the points of view with much care; while the airplane photographs were made especially for the album under directions furnished by the author. The pictures are accompanied by brief descriptive texts, and both together give the reader an excellent mental image of the region treated. Maps show the locations of all places mentioned, and in addition there is an indication of the French topographic sheet upon which the area pictured will be found.

The first album issued deals with the Mediterranean region and comprises sixty-one plates with some two dozen pages of text. For variety of forms the region is well chosen to introduce the series; for the maturely dissected mountains of southeastern France, the gently sloping plain at their base, the rivers flowing in narrow gorges or wandering aimlessly amid countless sand bars on broad flood plains, and the youthful shore line with its bars, deltas, rocky peninsulas, and islands are the subjects of a succession of pictures remarkable alike for their scenic beauty and their scientific interest. Geographers will wax enthusiastic over the airplane views of the ports of Marseilles and Cette with their basins, of the double *tombolo* of Giens, of the braided Var River, and the "close-up" views of the curious weathering forms in granitic rocks known in Corsica as *tafoni*. And where will the ordinary traveler find such admirable views of Carcassonne, Aiguesmortes, and Monaco as the airplane pictures made for this album? When one remembers that the significance of the features shown is explained in non-technical language by a geographer of international reputation, aided by two capable associates in geography and history, he will agree that the new series of albums should prove most useful not merely to those scientifically trained, but to all who are interested in La Belle France.

In this second volume, dealing with the "Cévennes et Causses," the geographic unit widely known as the "Massif Central" is first described, and its four subdivisions named. Two of the latter, the Limousin and the Auvergne, are reserved for later treatment. Here the high, rugged southeastern portion of the Massif Central known as the Cévennes, and the southern areas covered with limestone known as the Causses, are described in detail and illustrated with numerous excellent photographs. The picturesque spurs and deep valleys of the one, the steep-walled plateaus, rocky canyons, caverns, sink holes and natural arches or bridges of the other, form the subject of some dozens of instructive geographic studies. Incidentally one learns something of the modern home of Roquefort cheese and of the prehistoric dwelling places of early man.

DOUGLAS JOHNSON

A FRENCH REGIONAL MONOGRAPH

ANDRÉ DAVID. **La Montagne Noire (Aude, Hérault et Tarn): Essai de monographie géographique.** With preface by Emmanuel de Martonne. 226 pp.; maps, diagrs., ills., bibliogr. *Mémoires Soc. d'Études Sci. de l'Aude*, Vol. 2. L. Bonnafous, Carcassonne, 1924.

Beyond the limestone table-land of the Causses the Cevennes are prolonged towards the southwest by a massif which by its well-defined characteristics is sharply distinguished from the surrounding regions. This little geographical entity, the Montagne Noire, is the subject of a monograph by André David, a student of the École Normale Supérieure, who was killed early in the war and whose work has now been put into shape and published. Professor de Martonne has written a preface, and M. Léo David, father of the author, has furnished panoramic sketches. These illustrations merit special comment: altogether 100 were made, forming an iconography the like of which does not exist for any other French region. Those not reproduced in the volume are on file at the Sorbonne.

The topography of the Black Mountain is varied: the southern border overlooking the plain of Lower Languedoc is cut up by deep gorges; the center appears as a little-dissected plain. The author has recognized a series of erosion cycles, special interest residing in his demonstration of a fossil peneplain (pre-Eocene) which extends over all the southern part of the Black Mountain. The opposition between south and north is marked as regards distribution of winds and rainfall. Blowing over the Mountain from south to north and vice versa, winds change their characteristics and names: the *cers*, humid in the north, is transformed into the dry *transmontane* of Languedoc; the *marin*, humid and soft in the south, becomes the dry and violent *autan* on the north. The north is open to Atlantic influence; the south to Mediterranean. The vegetation reflecting these varied influences is correspondingly varied, and the author devotes an interesting chapter to this important subject.

On the economic side of the study special reference may be made to the treatment of the industrial evolution of the region. Here the local production of wool and the presence of numerous streams have encouraged the textile industry from early times. After 1830 the industry took on considerable importance. Local sources of material became insufficient, and in 1851 importation began from the La Plata region. Thanks to good equipment and excellent organization the industry has continued to prosper.

Valuable notes are given on house types and villages and on the population and its movements. In sum, the work of this young author, though not a finished study, is an excellently conceived monograph of a type all too rare in geographical literature.

M. Lebrun

Turkey and Constantinople

George Young. **Constantinople.** vii and 310 pp.; map, ills., index. Methuen & Co., Ltd., London; George H. Doran Co., New York, [1926.] $5.00. 9 x 6 inches.

A. J. Toynbee and K. P. Kirkwood. **Turkey.** xiv and 329 pp.; maps, bibliogr., index. (The Modern World: A Survey of Historical Forces, Vol. 6.) Ernest Benn, Ltd., London, 1926. 15s. 9 x 6 inches.

> "*Master of the Caravan:*
> Open the gate, O Watchman of the night.
> *Watchman:*
> Ho, travellers, I open. For what land
> Leave you the dim-moon city of Delight?
> *Merchants:*
> We take the Golden Road to Samarkand."

With these lines George Young closes his picturesque introduction and gives the keynote of the substantial text that follows. The first part of the book deals with the Roman Empire, the second with the Byzantine Empire, a third with the Ottoman Empire. The final section describes the Turkish nation and covers the period from the Young Turk revolution of 1908 to the present time, with the government transferred to Angora: "no doubt a good place to work; for there is nothing else to do." The period of Roman occupation is told in terms of the oldest architecture of the city, that of the Byzantine Empire in terms of its walls, whereas the Osmanli Empire story is bound up with the mosques and bazaars of Stamboul and the lives of its sultans. Under the Romans Constantinople grew until it drew into its markets the wealth of the known world "from China to Caledonia and from Scythia to the Sahara." Thus its history is related to many of the vicissitudes of world history. Every major event of the Black Sea coast was registered here, Greeks and Romans struggled for its possession, Turk and Christian besieged it. Peter the Great and Catherine after him made it a prime object of empire. The trade of Genoa and Venice was largely dependent upon it, and throughout its whole history the shipping of these two cities has passed its gates or lain in its harbor. Even during the Osmanli Empire the association of Constantinople with the Italian cities continued. The Turks broke at last with Venice, and this break but shortly preceded Lepanto and the crushing of Turkish sea power.

Because Constantinople was the greatest of medieval marts the Turkish sultan could well style himself "Lord of the Upper and Lower Seas." He threatened to invade Germany and even France: "to our forefathers Constantinople was a word of terror." In the history of Constantinople we may find a reason for the development of silk culture in Anatolia when the heavy customs duties under the later Roman rulers retarded commerce and the import of silk from China died off only to have the culture of the silkworm taken up on home territory and be continued down to the time of the expulsion of the Greeks a few years ago. Those extraterritorial privileges, the capitulations, we see not as a modern development only but one that reaches back for more than a thousand years as foreign colonies were established by the Turks who forcibly brought in Greeks from Thrace and Trebizond and thus restored the city to its position as the center of world commerce, offsetting the destruction wrought in its capture and the decay it suffered in the later Byzantine period immediately preceding Turkish occupation. Just as the aqueduct and cistern built by Valens are still in use and traces of the Anastasian wall may still be seen, every period marked by its own peculiar culture, so the capitulations come down with many mutations to our own time. They were not due to the administrative incapacity of the Turk but were built up consciously as an international institution, seemingly the best arrangement that could be made in a city that was destined by nature and history to be a great international commercial center.

Though the greater part of the contents of the book on Turkey, as well as the interests of the authors, are historical, there is a goodly quantity of material of geographical value. Moreover, the geographer who wishes to understand the new state of Turkey would do well to read so important and interesting an account of its historical development.

Turkey's history is largely a record of the clash of cultures and civilizations upon Turkish soil as the Central Asiatic invaders moved westward to control a native peasantry over which Persian, Greek, and Roman had successively held sway. Still more important was the stride by which the leaders crossed into Europe and maintained themselves in power athwart the great arteries of communication between the different parts of the Near East. The withdrawal of the government to the interior town of Angora in the present régime has of course greatly stimulated the growth of that small provincial city, but this is offset by a decline of greater magnitude in Constantinople, which was so long the religious, strategic, and cultural center of the Ottoman Empire and the hope of Islam. Constantinople is now a distant seaport town, and if its neglect continues Smyrna, which formerly led in exports and was second in imports, will become the leading city.

Realizing that Turkey is not an industrial state and that agriculture is almost the sole support of the people, the new government has shown a progressive spirit in introducing modern agricultural implements, establishing agricultural schools, and carrying forward a campaign of agricultural propaganda. It has also extended special privileges to industry in order that Turkey might enjoy some measure of independence with respect to imported manufactures. The government is still faced with the problem of attracting foreign capital in order to extend the railways, which, next to agriculture, have been the chief object of solicitude. With her outlying territories cut off and the attention of her leaders concentrated upon domestic problems, with western breezes blowing through the country, and particularly with the modernization of the codes of law, Turkey promises to emerge at last from its medieval state and become a modern power.

The Economic Development of South Africa and the Belgian Congo

M. H. de Kock. **Selected Subjects in the Economic History of South Africa.** ix and 475 pp.; maps, diagr., index. Juta & Co., Ltd., Cape Town and Johannesburg, 1924. 15s. 9 x 5½ inches.

In the early days of the development of South Africa as a home for white men the political and social problems, if not simple, at least had simple solutions applied to them. The relation of white to native was much less a matter of concern, the mineral and pastoral riches of the country offered such extraordinary rewards, and frontier trading allowed such high profits to the venturesome that the eyes of governments and colonists were fixed upon the future rather than upon the present.

The addition of German Southwest Africa, the definite fixation of boundaries and mandates, and especially the termination of the special privileges enjoyed by the great trading companies, mark the full opening of a new and highly complex stage. The author of this book traces the steps by which the white man has come into his present inheritance of resources and troubles, and he does it in a thorough manner with excellent technique and that highly specialized knowledge in the various sciences which a community with varied resources has to take account of. He deals thoroughly with forests and mines, farms and orchards, shipping and railroads, labor and capital, banking, taxes, and last and most acute of all, the "poor white" problem, which he shows is fundamentally a rural problem since the great bulk of the poor whites are Dutch-speaking and of rural origin. In recent years the poor white problem has become also an urban problem because of growing industrialism and the drift from the country to the town. The problem has been complicated by the competition between white and colored in the unskilled and semi-skilled occupations in urban industries and the lack of any real industrial education. The problem has been dealt with still more fully in the lectures by Professor W. M. Macmillan entitled "The South African Agrarian Problem and Its Historical Development," Johannesburg, 1919. While the old style drift of the pioneer, or trek Boer, into the remote and undeveloped districts of the Northwest and Bechuanaland continues, the chief movement is from the drier areas to the coast belt and the low veld (p. 87). Macmillan touches the heart of the problem of the poor white in showing how the trek Boer became the normal type. His farming was extensive rather than intensive, he roved for roving's sake, there were no facilities for education, even the tradition of learning was destroyed. Now that intense competition has come through increase of population, and land is no longer easy to get, the ignorant farmer has little chance, and he presents one of the major problems of the Union.

La politique économique au Congo belge: Rapport au Comité permanent du Congrès colonial. v and 333 pp. (Bibliothèque-Congo [Publ.] No. 15.) Goemaere, Brussels, 1924. 10 x 6½ inches.

By a series of political steps taken during the last third of the nineteenth century, Belgium became in a sense the trustee in the first instance of that immense tract of tropical territory now known as the Belgian Congo. If mistakes have been made in administration it must also be said that on the whole relations both with the natives and with the bordering powers have markedly improved. The political and economic geography of the region is made the subject of this monographic report, which deals not only with the statistics of production and exchange but with industry in all its phases from the small rural establishments to those that work under government aegis. Extensive is the effort of the state to penetrate to the life of the native villages, to improve their methods of production, to balance the organized life region by region so that one industry may not prosper at the sacrifice of another. The forests, the mines, pasturage, horticulture—all these are treated exhaustively. The report is written in the spirit of development and with an eye to the future and deals rather with the facts and the future of material development than political policies.

HEALTH IN THE TROPICS: NORTHEASTERN AMAZONIA

R. P. STRONG, G. C. SHATTUCK, J. C. BEQUAERT, AND R. E. WHEELER. **Medical Report of the Hamilton Rice Seventh Expedition to the Amazon, in Conjunction with the Department of Tropical Medicine of Harvard University, 1924–1925.** xvi and 313 pp.; map, ills., bibliogr., index. (Contribs. Harvard Inst. for Tropical Biology and Medicine, No. 4.) Harvard Univ. Press, Cambridge, Mass., 1926. 10½ x 8 inches.

To the uncritical, every advance in tropical medicine is hailed as a crossing of one of the last barriers to white occupation and exploitation of the tropics. The modern sanitation methods now employed in tropical cities of Central and South America have steadily driven out, or reduced to manageable scope, perhaps the most dreadful of tropical diseases, yellow fever. The reports, and especially the maps, published by the Rockefeller Institute show this clearly. But no amount of medical research can lessen the ardor of the tropical sun, no man-created agency has been able to conquer in a practical way the overwhelming pest of insects, no necromancy can combat the tropical rainfall. The seasons, like the tides, are immutable, and as concerns white occupation of the tropics their effect upon human physiology is of equal importance with advances in medical science.

The above report, while chiefly concerned with technical medical matters, contains some arresting paragraphs bearing on the geographical side of the question. It opens with a chapter on the Amazon forest that is particularly valuable because written from the medical man's point of view. Two paragraphs from it deserve quotation because they give in compact form a statement to which heed should be given by every optimist in tropical development.

"The virgin forest of the Amazon offers little hospitality to the traveller, and it has perhaps been appropriately named by Alberto Rangel the *inferno verde*, where one soon dies of hunger, and during the dry season suffers from thirst, when almost all the streams which traverse it are reduced to some few puddles of stagnant or brackish water. It is too thickly and too regularly grown to be grand or picturesque, and too silent to be cheerful. It breeds too much vermin to be agreeable, and produces at length upon the traveller vague sensations of sadness, oppression, and uneasiness, which cause him to breathe a sigh of relief or to cry out with joy when chance conducts him to some *campinarana*, or small prairie, or when he reaches the sunny banks of a stream with billows tumbling among the rocks of its yet imperfectly excavated bed" (p. 10).

"The natives of Amazonia outside of the cities and towns live usually in small groups of palm-thatched huts, situated on the banks of the rivers or small streams, but occasionally located inland in the forest which has been cleared in their vicinity. The conditions of life in these settlements are most primitive. None of the houses is screened, nor are mosquito nets, except in very exceptional instances, used at night. The natives are exposed both night and day to the bites of all insect life. No hygienic measures are taken by the inhabitants of these localities in the disposal of excreta, the care or sterilization of drinking water, or other precautions against disease. There are no physicians and no drug or chemists' stores outside of the cities. Generally speaking, the inhabitants living upon the river banks show evidence of either acute or chronic disease, or the effects of having suffered from such disease. Portions of Amazonia to-day constitute some of the most unhealthy and most dangerous regions to reside in, from the standpoint of health, that exist in the tropics" (p. 13).

In every section of the report are equally important statements as, for instance, in Part II where Joseph Bequaert writes of medical and economic entomology. He here describes the characteristics of the evergreen rain forest, its ecological types, the seasonal habits of the rising and subsiding waters, and the nature of the insect pests. His meteorological observations on the upper Rio Branco are particularly important. The rôle of the ants in tropical economy should also be mentioned especially (p. 180). Shattuck's "Observations on the Branco, the Uraricuera and the Parima Rivers" are noteworthy because of the fact that we are here in a climatic province that departs from the true Amazonian type. His notes on the vegetation and the population and his medical observations upon them give one an admirable insight into the terrific handicaps of tropical life in this distant frontier.

All of the descriptions of the Amazon country in the report should be read with frequent attention to the map, for, while Amazonia is a term frequently used, the observations of the writers were confined to but a part of this vast realm; so that not all of the generalizations are to be taken as applying to the whole of Amazonia.

THE VOLCANOES OF CENTRAL AMERICA

CARLOS SAPPER. **Los volcanos de la América Central.** 116 pp.; ills., index. (Studien über Amerika und Spanien, Extra Series, No. 1.) Max Niemeyer, Halle, 1925. M. 8. 9½ x 6½ inches.

CARLOS SAPPER. **El infierno de Masaya.** 65 pp.; ills. (Studien über Amerika und Spanien, Geogr. Series, No. 2.) Max Niemeyer, Halle, 1925. M. 4. 9½ x 6½ inches.

The University of Würzburg is undertaking a series of monographs in Spanish, on Spanish America, of which the above are the leaders. The first is based on Dr. Sapper's well known book of 1913 on the same subject, with some additions due to later observations by himself and others. The author gives a general account of the volcanoes with a list of the more important ones, their geographical positions, and eruptions. This covers 22 pages. The rest of the monograph consists of descriptions of individual volcanoes and their histories. The descriptions are mainly physiographic, but some account is given of the petrology. There are some good halftones of volcanoes in eruption, but the actual phenomena of the eruptions are not described. A map showing the relative positions of the volcanoes would have been a real help to the reader.

When the Spaniards invaded Central America early in the sixteenth century, they were greatly impressed by the volcano Masaya, in Nicaragua. This volcano is of special interest because at that time it contained a lava lake, which Sapper tells us was quite similar to the present lava lake of Kilauea. It has long since disappeared. Some of the Spaniards thought that here was an opening into the lower regions; others thought the liquid lava contained gold and silver. After a few pages of introduction dealing with the earlier and the modern observations and the sources of information, nine of the early documents are reprinted. They were all written in the sixteenth century, and apparently all refer to visits made to the volcano in the first half of the century or very little later. Vulcanologists will be grateful to Sapper for making these documents accessible; beside their general historical interest they will show, by comparison with modern accounts, what changes have taken place in the last four hundred years.

HARRY FIELDING REID

A NEW THEORY OF VOLCANISM

ARTHUR L. DAY. **Some Causes of Volcanic Activity.** Ills. *Journ. Franklin Inst.*, Vol. 200, 1925, pp. 161–182.

ARTHUR L. DAY AND E. T. ALLEN. **The Volcanic Activity and Hot Springs of Lassen Peak.** 190 pp.; maps, diagrs., ills., index. *Carnegie Instn. Publ. No. 360*, Washington, 1925. 12 x 9 inches.

The studies of Kilauea and Lassen Peak, which Day and his colleagues have been pursuing for some years, have borne fruition in a new theory of volcanic eruption, which Day has set forth in his address before the Franklin Institute. He presents his facts and makes his deduction in such a logical and lucid manner that he is quite convincing. He recalls Jaggar's observation that the lava in the lake on Kilauea is 100° C. hotter at the surface than 20 feet below; he describes the gases collected near the surface of the lake, and shows that chemical reactions, with the evolution of heat, must be taking place between them; and the natural deduction is that the high temperature of the lava is due to these reactions. When the lava lake sank 700 feet in 1924 it laid bare the conduit; the rocks at the bottom were crystalline and not glassy; they were not solidified lava. And when the lava again poured into the conduit, it did not rise from the bottom but poured in from several points well up on the sides. The gases collected even from the same vent near the lake were in different proportions at different times. These observations, together with the known independence of level of the lava in Kilauea and in Mauna Loa, lead to the conclusion that the two are not connected but are independent systems each fed by lava from a number of independent pockets, and the gases in the lava from these pockets differ in composition. The pockets are considered unsolidified spots in a slowly cooling earth. By the analyses of the gaseous content of rocks Day is led to the conclusion that the magma in the pockets is slowly crystallizing and giving off gases. If the gases are principally water vapor, as was true at Lassen Peak, the pressure will gradually rise until there is an explosive eruption at a relatively low temperature; if other gases, which react chemically, predominate, the temperature will be high, the rock will be melted, and lava will flow. Day firmly rejects the idea that volcanoes are safety valves connected with a central reservoir, or that they are due to some special source of heat, such as radium. On the contrary, they are phenomena due not to heating but to gradual cooling; he reaches the conclusion in his own words, "that volcanoes are local and superficial developments representing (geologically) the last stages of crystallization in a mass of magma below, of which little remains fluid, and this in small (as geologic dimensions go) pockets, which are quite variable in gas content, pressure, and conditions of chemical equilibrium." These views are certainly revolutionary; but I believe they will hold.

The monograph on Lassen Peak, with its many beautiful illustrations, gives the history of the eruptions of that volcano since 1914; it gives in detail field observations and laboratory studies, analyses of rocks and gases, temperatures and changes of the hot springs. The immense quantity of water vapor given off in the eruptions are considered to be principally magmatic, whereas the water of the hot springs is thought to be principally meteoric, heated by water vapor ascending from the hot magma below. The book is full of definite information and is an important contribution to volcanic literature. The conclusions reached, bearing on the general theory of volcanic action, are mentioned in Day's address before the Franklin Institute.

HARRY FIELDING REID

Glacial Periods in the Earth's History

A. P. COLEMAN. **Ice Ages, Recent and Ancient.** xliii and 296 pp.; maps, ills., bibliogrs., indexes. The MacMillan Co., New York, 1926. $4.00. 9 x 6 inches.

The number of the ice ages in the earth's history accepted by Coleman is 11, but a few of these are regarded as somewhat doubtful. The geological periods of extensive glaciation are, in direct order: Keewatin, Timiskamian, Huronian, Animikian, Keweenawan-Cambrian, Ordovician, Silurian-Devonian, Carboniferous-Permian, Triassic-Jurassic, Eocene, and Quaternary. Four ice ages stand out from the rest by their great intensity, viz. the Permo-Carboniferous, Keweenawan-Cambrian, Quaternary, and Huronian, mentioned in order of importance.

None of the hypotheses advanced as to the causes of extensive glaciation is considered adequate to explain the localization of the glaciations, the alternation of glacial epochs and interglacial periods, etc. No single theory is advanced, but it is suggested that a conjunction of a number of conditions, astronomic, geologic, physiographic and atmospheric may be necessary to produce such catastrophic events in the earth's history. The reviewer agrees heartily in this.

The work shows the importance that the ice ages have played for the earth and its inhabitants. It points out how the discoveries of extensive glaciations in the remote past have fundamentally changed old conceptions of high temperature during those ages.

Personal study of glacial formations of all ages in all parts of the globe, about which the matchless collection of tillites, glaciated boulders and ledges, varved slates, etc., in the Royal Ontario Museum, Toronto, bear witness, has made Professor Coleman the foremost authority on the subject; and as a consequence this excellent and beautifully published treatise is of exceptional value.

ERNST ANTEVS

A THEORY OF THE DOLDRUMS

C. S. DURST. **The Doldrums of the Atlantic.** Map, diagrs. *British Meteorol. Office. Geophys. Memoirs No. 28 (Eighth Number of Vol. III)*, pp. 229–238. London, 1926.

These are times in meteorological investigation when more and more attention is being directed to fluctuations—seasonal, annual, and in longer periods—in the great wind and calm belts, and in the "centers of action," of the general circulation of the earth's atmosphere. This circulation may best be thought of as a machine. It does not "run true" to "normal" but is subject to fluctuations which often involve variations in seasonal weather of great economic importance.

In the present monograph the author discusses that most interesting of all the wind and calm belts of the world, the doldrums—the region of calms and light variable winds within the equatorial trough of low pressure between the trades. Mr. Durst has made a thorough study, by means of isopleth and other diagrams, of the characteristics of this belt, using all available data. The doldrums are found to vary considerably in their position, and these fluctuations are associated with variations in the humidity of the trade winds. The generally accepted theory is that the high temperatures near the equator cause the air there to expand; air moves away polewards; a low-pressure belt results, and convection then produces the characteristic clouds, squalls, and rainfall. The author finds that the maximum temperatures seem to have less to do with the seasonal variations in the position of the doldrums than do the maximum pressure and the maximum humidity. He, therefore, suggests an alternative theory, "that the heat energy of the sun is stored by evaporation in the trade winds and this energy is released by convection (started either dynamically or thermally) in the doldrums." Convection results in the movement of the air polewards; the pressure gradient towards the doldrums becomes steeper, and the trades blow faster. In other words, an increase in the humidity of the northeast trades would tend to move the northern edge of the doldrums northward, "since the same aqueous stage in the air's progress would be reached at an earlier date." The lowest pressure would thus tend to follow the position of the greatest humidity rather than the position of the maximum temperature.

If the author's theory "that the convection of the doldrums is an important factor in the atmospheric circulation" is correct, the rainfall of the doldrums is a "direct expression of the energy released in the conversion of water vapor and must be related to the forces which govern the general circulation." A numerical relationship of this sort is found between the energy released in the doldrums and the energy that is dissipated by turbulence in the general circulation.

Mr. Durst's paper is interesting and suggestive. Although he makes no reference to the possible future use of his conclusions in relation to long-range forecasts, it is natural that the thought of his readers should run in that direction.

R. DEC. WARD

REPRODUCTIONS OF EARLY MAPS

G. CARACI. **Tabulae geographicae vetustiores in Italia adservatae.** Vol. 1, 18 pp. of text and 20 pls. in portfolio. Otto Lange, Florence, 1926. 20 x 14 inches.

These maps are reproduced and explained as a contribution to the history of geographical knowledge in the period of the great discoveries. The present volume contains seven maps: a world map by Lopo Homem (1554); a map of Europe by Diego Homem (1563); a map of North and South America by Paolo Furlani (1574); an anonymous English map of the east coast of South America thought to be derived from the Cavendish expeditions to the South Sea; an Englishman's (Gabriel Tatton) map of the Pacific (end of the sixteenth century); Cornelis Doetz's map of the Indian Ocean (end of the sixteenth or beginning of the seventeenth century); and a map of the North Sea by Evert Gysbertsoon (1601).

None of these maps can lay claim to the importance attaching to the Behaim globe of 1492 or to the great Waldseemüller maps of 1507 and 1516. Neither can they excite the interest aroused by the La Roncière map two years ago. However, Signor Caraci's volume does rival both in importance and interest the contemporary work of Dr. F. C. Wieder. It is an important step towards making easily accessible to scholars all of the maps remaining to us from the period of the great discoveries.

Maps by their very nature become obsolete. This fate overtook them more rapidly in the great discovery period than it does today. In the period between obsolescence and their being sought as valuable historical records map mortality is very high. Many thousands of these precious historical records have now been lost forever. The most valuable maps of Columbus and his successors were manuscript maps on separate pieces of parchment. These, unlike the printed map bound in a book, had nothing but their own value to cause them to be saved; and the few that, by various happy accidents, have remained to our day are more inaccessible than the printed maps.

Historians were early confronted with obstacles in properly using the great cartographical records of discovery and exploration. Governments were very jealous of the secrets of their enterprises especially as revealed in maps. As a result writers, down to recent years, have relied almost exclusively on public records, contemporary letters, and secondary sources and as a rule have either not used contemporary maps at all or have employed them as curious pictures. Among American historians Justin Winsor may be noted a conspicuous exception to this statement.

One of the greatest difficulties of the historian is to avoid interpreting the past in the light of present knowledge. Public records, letters, and books are peculiarly liable to be so misinterpreted. Old maps are freer from the danger of being so misused than any other form of historical record. Therein lies part of their peculiar value. The insertion of old map reproductions in histories also enables the reader to sit in judgment with the historian without filling the work with disjointed material to its detriment as literature.

When a picture is taken with a single-lens camera it is true according to the point of view, but it is a flat record. If, instead, a double-lens camera be employed there is introduced a perspective that gives new meaning to the picture. So there is a new meaning given to the history of the period of geographical discoveries if, to the public records, contemporary letters, and printed books, there be added the reproduction of contemporary maps. Thanks to the work of Santarem, Jomard, Kunstmann, Kretschmer, Nordenskiöld, Fischer, Marcel, von Wieser, Stevenson, Ravenstein, and others, the student of history today is not limited as were the students of other days. But much remains to be done.

Every reproduction of a rare old map is in effect the same as the reproduction of a rare volume of history. Today the students of historical geography are in a position to render obsolete most of the existing histories dealing with the great geographical discoveries. Signor Caraci deserves thanks from students of historical geography. It is to be hoped the succeeding volumes of his work will maintain the high quality shown in the twenty plates of the first. There are unfortunately many errors in the valuable English text. However, they are not of a nature that can detract from the value of the map reproductions.

George E. Nunn

A Symposium on Population Problems

Louis I. Dublin, edit. **Population Problems in the United States and Canada: An Outgrowth of Papers Presented at the Eighty-Sixth Annual Meeting of the American Statistical Association, December, 1924.** xiii and 318 pp.; diagrs., index. (Publs. Pollak Foundation for Econ. Research, No. 5.) Houghton Mifflin Co., Boston and New York, 1926. $4.00. 8 x 5½ inches.

This book is announced as an outgrowth of a symposium held by the American Statistical Association at its annual meeting in 1924. Its purpose is to give systematic attention to our population problems rather than to explore scattered and minor details. It aims to replace "the prevailing unscientific and almost arrogant attitude on population questions" with a spirit of scientific investigation to the end that a practical and liberal population policy may eventually be developed. Problems dealt with include the growth of population in the United States, its rapid urbanization, its optimum size (as opposed to possible size with a lower standard of living), agricultural and mineral resources and capacities of the United States, national composition, difficulties of immigration and the new restrictive immigration policies, the effect of the employment of women; and the prognostic element is not lacking in a final paper entitled "Trend of Population with Respect to a Future Equilibrium." That Canada is coupled with the United States in a study of the problem is as it should be, seeing that Canada's population is a broad fringe to our own.

The volume is all compact of statistics and other specific elements, as might be supposed from such an origin. It is not without philosophical discussions, and the philosophies naturally do not always agree. However, the student as well as the policy maker of the future will be concerned not so much with the philosophy of the book as with its ideas concerning the relations of people and land, of race to race, and of the specific attempt which the book makes to arrive at a discussion in terms of national policy. This is a healthy sign, for the machinery of knowledge is now so vast that not merely data but the meaning of data and the practical measures which policy makers are to frame and carry out are of immediate importance. If government is to be guided by facts the facts will have to be put in clearer and much briefer form. It would be a great gain if a book of fifty pages could now be written on the basis of this book of 310 pages and if it were made small enough to go in the coat pocket of every congressman.

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Mapa de la Republica de Panama, 1:500,000 [7.89 miles to 1 inch] compiled from over 100 original surveys, many of them unpublished. Printed in five colors. Follows in general the scheme of the International Map of the World on the Millionth Scale, but hypsometric tints have been omitted and the provinces shown in color instead. Accepted as official map by the government of Panama. 33 x 63 inches. 1926. $3.00.

Separate Maps published in the *Geographical Review* and the *Bulletin of the American Geographical Society*, the majority in color. 25 cents each. A list will be sent upon request.

THE
GEOGRAPHICAL REVIEW

VOL. XVII APRIL, 1927 No. 2

NORTHERN ARABIA

THE EXPLORATIONS OF ALOIS MUSIL

John Kirtland Wright

FIG. 1—Tomb at Madian.

THE desert zone of northern Arabia and Mesopotamia is exceptionally rich in historical and geographical interest. Preserved in Babylonian and Assyrian tablets, in Old Testament records, and in the writings of Greek, Roman, and Moslem historians we find many references to the nomadic tribes of the waste lands beyond the settled country. Cuneiform inscriptions tell of campaigns of the great military monarchs of Assyria westward to the Euphrates and beyond. Within the frontiers of Rome and Byzantium, which crossed the northwestern edge of the desert zone, towns flourished, forts and paved roads were built, and with the coming of Christianity churches and monasteries were established, where now all is barren and deserted. The clue to much of the early history both of Judaism and of Islam may be sought in the relations between the free rovers of the open wilderness and the settlers in the oases which fringe the desert's margin and are hidden in the basins within its spacious interior.

From the earliest times northern Arabia has lain near the very heart of the "known world" of geographers; nevertheless, even today it offers to the pioneer explorer the allurements of the unexplored and to the scientist a vast and almost untouched field for intensive study: there still remain here tracts that have never been seen by western eyes.

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Among the explorers of northern Arabia, Alois Musil, now Professor of Oriental Studies at Charles University, Prague, holds a unique position, by reason of the extent, continuity, and thoroughness of his observations. Through the generosity of Charles R. Crane, Esq., the American Geographical Society is enabled to publish the results of Professor Musil's expeditions of 1908–1915,[1] the routes of which are shown on Figure 2. The purpose of the present article is to explain something of Musil's methods in the field and to indicate in a very general way the most important geographical[2] results of his many seasons of wandering in Arabia and of his years of research into the historical geography of that peninsula. To arrive at a better understanding of the reports about this region that have come down from antiquity; to gain some insight into the origin and evolution of monotheism, a concept which, perhaps, is peculiarly characteristic of the thought of desert folk; to throw some light on the part that Arabia has played in the broader history of civilization: these were the general objectives sought and they could be attained only through a minute study of the country and people. Most modern scholars who have treated the history of desert Arabia have not had sufficient mastery of detailed topographical and ethnographical facts to warrant many of their conclusions and generalizations.

Relations with the Bedouins

Although peace and public security now reign throughout much of interior Arabia under the strong rule of Eben Sa'ūd, this condition is altogether exceptional. The normal state of affairs is one of virtual anarchy. Under the Turkish régime the real authority of the government did not extend beyond the borders of the occupied territory; Turkish garrisons in the remote frontier posts, instead of holding down the desert tribes, were more often virtually beleaguered. In the open desert, tribe warred with tribe. The Shammar declare that what agriculture is to the fellah, or settler, raiding is to the nomad, who spends the whole year in hostile incursions on his neighbor's camps and camel herds.[3]

---

[1] Professor Musil's works as published by the Society will consist of six volumes, forming the first six numbers of a series *American Geographical Society, Oriental Explorations and Studies.* Of this series, No. 1, "The Northern Ḥeǧâz" was published late in 1926. The other volumes, which will appear in the near future, will be as follows: No. 2, "Arabia Deserta"; No. 3, "The Middle Euphrates"; No. 4, "Palmyrena"; No. 5, "Northern Neǧd"; No. 6, "The Manners and Customs of the Rwala Bedouins." Musil's routes as described in each of these volumes are shown on Figure 2. Three maps accompany Musil's works: "Northern Ḥeǧâz," 1: 500,000; "Northern Arabia," 1: 1,000,000 (in 4 sheets); and "Southern Mesopotamia," 1: 1,000,000. In the present article definite page references can be given only to "The Northern Ḥegâz," which is in print, and to the first part of "Arabia Deserta," which is in page proof form at the time of writing. In Professor Musil's work Arabic names are transliterated according to the continental European scheme of transliteration. In the present article, however, the transliteration, even in quotations, follows the English usage, except in Figure 2.

[2] In the footnotes and appendixes to Musil's works there are included many citations and discussions which should be of interest to every student of Oriental history—ancient, medieval, or modern. In the present article no attempt is made to deal with these more strictly historical questions, nor does the scope permit of comparison with other geographical studies.

> A Bedouin yearns for booty day and night, not so much to enrich himself with it as for the thrill of capturing it; and the greater the danger the more alluring the adventure. As soon as the booty is safe in his hands, it ceases to please him: he gives away what he has captured and plans whither to go after fresh loot. . . . The Bedouins consider fighting as a sport.[4]

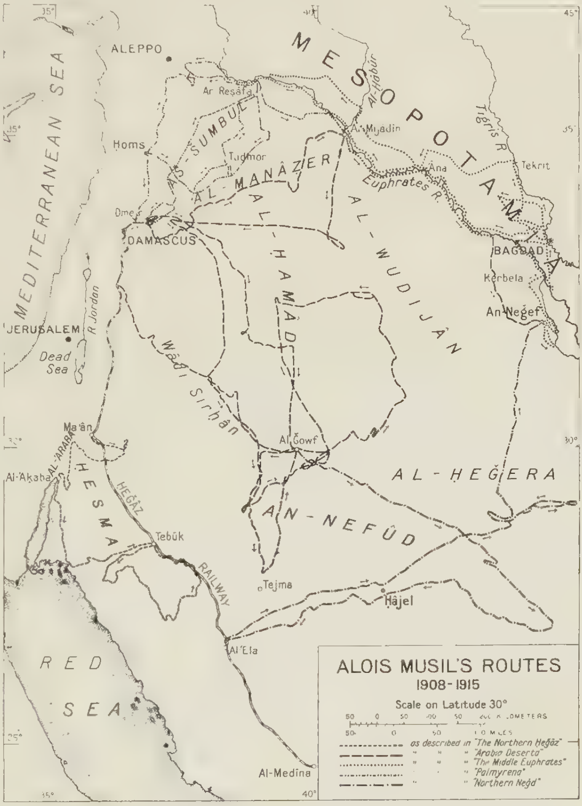

Fig. 2—Alois Musil's routes in Northern Arabia as described in the volumes now being published by the American Geographical Society. Place names on this map are transliterated as in Musil's works.

Not only was intertribal strife the order of the day, but outlaws and robbers lurked around the water holes awaiting an opportunity to strip and plunder the helpless traveler. When threatened by strongly armed parties these marauders would seek refuge amid the trackless ravines and crags of the lava fields or in the many other sanctuaries afforded by the boundless desert, where even the Bedouin himself dared not follow. The nomad's lawlessness, his lust for loot, and his supreme disregard for human life, rather than any religious fanaticism, was what rendered traveling in the deserts of Arabia so extremely precarious. Fanaticism is, rather, the product of the oasis towns.

Such being the condition of public safety under which his explorations had to be made, Musil soon became convinced that he could accomplish little of scientific value without the protection of the head chiefs of the powerful tribes in each of the regions he was to visit. Doughty had tried the experiment of traveling as a humble physician, trusting his skill as a healer and the integrity and force of his character to carry him through. As a result he was always more or less at the mercy of his hosts, often unable to control his movements from place to place and hampered in his facilities for observation. Musil, on the other hand, by cultivating and maintaining an intimate friendship with Ṭalāl eben Fāyez, chief of the Beni Ṣakhr, between 1896 and 1902 was able to carry out extensive explorations in the Biblical lands of Moab and Edom, the classical Arabia Petraea.[5]

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[3] Northern Neǵd, Ch. 1.

[4] Arabia Deserta, p. 424.

Pursuing a similar policy, the confidence of An-Nūri eben Sha‘lan, head chief or "Prince" of the Rwala, the mightiest tribe of Arabia (Fig. 3), was subsequently obtained. Through the aid of An-Nūri the journeys of 1908–1909 and of 1914–1915 were carried out, and at his headquarters Musil became acquainted with the chiefs of other tribes, "before whose countenance" he was enabled to visit domains beyond the territory of the Rwala proper. For instance, a friendship established with ‘Awde abu Tāyeh of the Ḥwēṭāt, whose wounded arm Musil cured at An-Nūri's camp in 1909, was confirmed in 1910 when Musil visited the Ḥwēṭāt at their encampment on the steppes east of Ma‘ān. ‘Awde made easy an extended journey through the northern Ḥejāz in 1910, supplementing to the south explorations carried out in 1898 and 1902. A similar friendship with Nāzel eben Thneyyān of the Shammar made possible the great journey through northern Nejd in 1915.

An-Nūri was known in the desert as bloodthirsty and remorseless; he himself boasted of having killed with his own hands no less than 120 men, and others told a dark tale of how he had shot two of his own brothers. Since Musil had himself taken part in a raid against a clan of the Rwala in company with his friends, the Beni Ṣakhr, his approach to An-Nūri was both difficult and dangerous, but, once friendly contact had been established, he was received on equal terms by the Rwala chief—an unconscious tribute to his knowledge of the vernacular of the desert and of Bedouin psychology and *mores*. He soon became more than a mere friend of An-Nūri; assuming the position of intimate adviser, on occasion, he even served as An-Nūri's trusted emissary to hostile tribes. He was accepted as a member of the ruling family of the Rwala and more than once actually rode at the head and in command of the migrating tribesmen. He tells of the manner in which he maintained his position:

> It was generally known that the Prince was my close friend; but I did not allow any of the chiefs to become too intimate. My deportment toward them all was

---

[5] In the course of these explorations he discovered the famous Quṣeyr ‘Amra (Fig. 11) near the head of Wādi Sirḥān, the only known Moslem building decorated with wall paintings which dates from as early as the eighth century of our era. See Ḳuṣejr ‘Amra, 2 vols., Kaiserliche Akademie der Wissenschaften, Vienna, 1907.

kindly and courteous, but it was reserved whenever any of them sought to treat me as his equal. In such a case I pretended not to hear what was said, or else I replied curtly in the negative, immediately afterwards engaging the man in a pleasant conversation as though nothing had happened.[6]

THE RWALA BEDOUINS

The Rwala are the only true representatives of the camel breeders, or Bedouins in the strict sense of the word. Camping and migrating with this great and powerful tribe between Damascus and the Nefūd (Figs. 4, 5, 6), wearing the same costume as its members, partaking in their varied daily activities, the explorer was able to observe their mode of life in all its details and to learn much of their keen but limited ways of thought. Most of his first-hand observations among the Rwala are systematically recorded in the volume, "The Manners and Customs of the Rwala Bedouins," but numerous incidents related in the other volumes help to complete the picture. Limits of space prevent any attempt to summarize the observations. A few characteristic anecdotes, however, may be quoted.

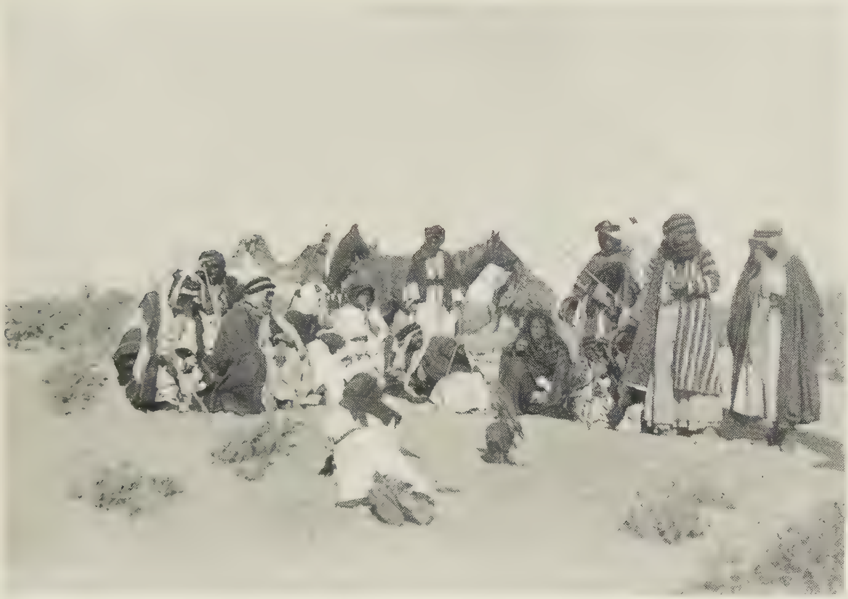

FIG. 3—A group of Rwala Bedouins resting in the Wādi Sirḥān. The figure reclining in the center is An-Nūri eben Sha'lān, head chief of the Rwala tribe. (Arabia Deserta, Fig. 17, p. 115.)

Something of the free attitude of other members of his tribe towards their ruler, An-Nūri, who has power of life and death over them, is shown in the following incident. Once, when on the march,

---

[6] Arabia Deserta, p. 300.

An-Nūri was obstinate, insisting on going in one direction whereas the tribe wished to go in another.

> As a result of this dispute the chiefs and their clans, as well as his nearest relatives, left him, turning toward the southeast in the direction of Al-Labba. Our party was thus diminished to the Prince, his slaves, his son Sa'ūd, and myself. About twenty minutes after the others had left we were overtaken by a young son-in-law of the Prince . . . , who reproached his father in terse but vigorous words for braving great danger because of his obstinacy and exhorted him to follow the others. The Prince accordingly swerved his camel towards the southeast, and we went whither the rest of the tribe was bound, to Al-Labba.[7]

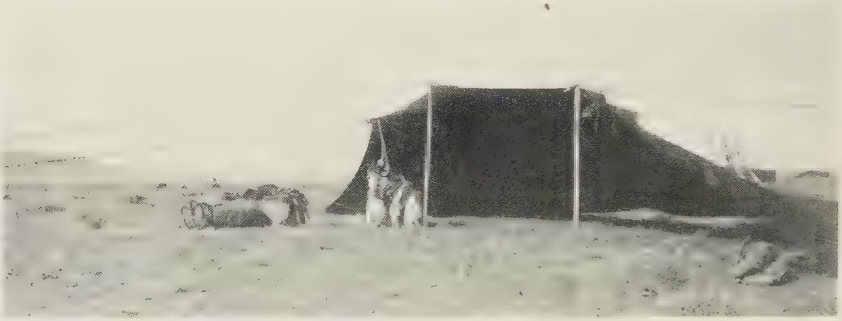

FIG. 4—A Rwala tent. (The Manners and Customs of the Rwala Bedouins, Fig. 8.)

In another passage Musil illustrates the Bedouins' extraordinary powers of reading tracks in the desert. On reaching an abandoned camp site his companions examined it very closely.

> At such places the nature of the tracks and excrement indicate whether there has been a camp of Bedouins or of the breeders of goats and sheep . . . and likewise whether the camp has been abandoned for a short time, for a month, or even for years. The size of the space where camels rested through the night and the tracks of horses mark the place where the chief himself camped, and the size and form of the fireplace tell his name and dignity. As soon as the visitors at such an abandoned camp site have decided on the chief's name, they know also who camped with him and then seek the tents of individual families. Being familiar with the approximate number of camels owned by the individual tenants, they inspect the particular spots for the camels . . . , look for stones upon which women put their kettles and which everyone fastens in the ground in her own peculiar fashion, measure the dimensions of the compartment reserved for men, observe the depth of the fireplace in which coffee is cooked, and distinguish the owner. Then come reminiscences of the tenants, of rendezvous and raids. It takes a long time to exhaust all the material for talk which such an abandoned camp furnishes.[8]

The Bedouins' skill in reading footprints is frequently commented on. For instance:

> Nāzel showed us how he manages to find out whether the tracks are left by one who habitually camps in the Nefūd [sandy desert] or of one whose camping grounds are stony tracts. The inhabitants of the Nefūd have broad feet and heels made

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[7] *Ibid.*, pp. 203–204.

[8] *Ibid.*, p. 402.

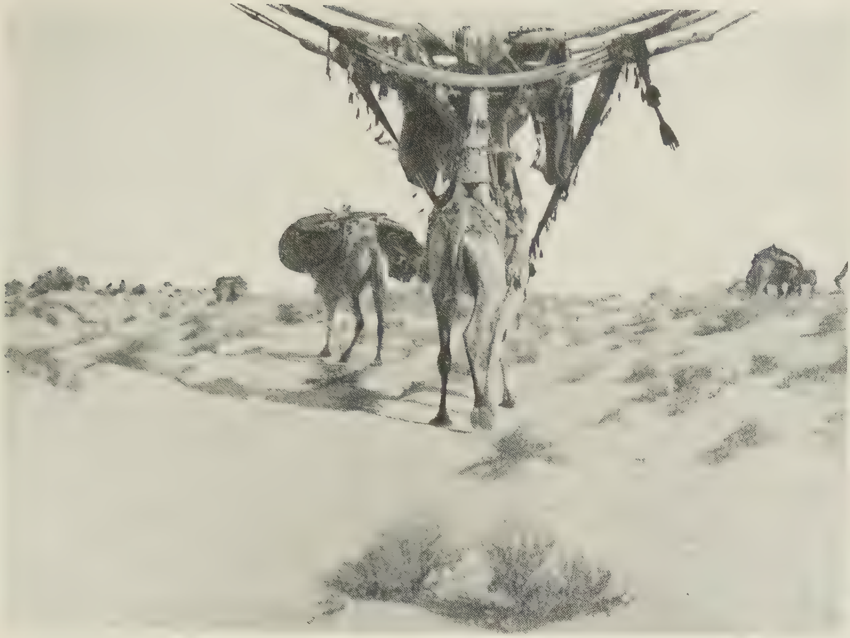

FIG. 5

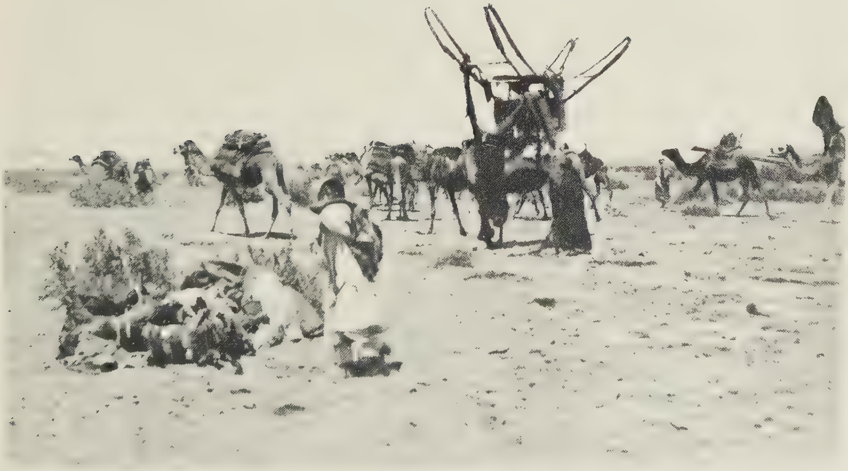

FIG. 6

FIG. 5—Rwala camel carrying a *zhetab* litter. Women and children ride in these magnificently decorated litters. (The Manners and Customs of the Rwala Bedouins, Fig. 17.)
FIG. 6—Rwala camels with a *zhetab* litter. (*Ibid.*, Fig. 19.)

smooth by sand, while the tribes camping in stony regions have feet narrow and heels scarred by stones.[9]

A Bedouin chief's ideas about the outside world are shown in the following remarks of An-Nūri shortly after the outbreak of the World War:

'Franj is the family still reigning over all Europe. As Eben Sa'ūd rules a large territory and various tribes, so the Franj have held under their sway many tribes like the Almān (Germans), Namsa (Austrians), Ṭalyān (Italians), Inklīz (English), Rūsiya (Russians), Mosqūb (Muscovites), Serbya (Servians), Rūm (Greeks), and others. Very many years ago the Rūm threw off their yoke, and this is the reason why they are called Rūm and not Franj. The Inklīz also have won a good deal of independence and are guided according to their own counsel and will; but by some they are still counted among the Franj, while others hold that theirs is a free country. Now the Almān and Namsa tribes have revolted against the Franj, although Serbya, Rūsiya, Mosqūb, and Inklīz still support them. The enmity is bitterest between the Inklīz and the Almān, about as it is between the Drūz (Druses) and the Rwala, or between the Akrād (Kurds) and the 'Amārāt or the Fed'ān. The Inklīz have many islands in the sea, upon which live many peoples whom they send against the Almān. The latter are the most proficient in the manufacture of arms; the best rifles, revolvers, and pistols come from them or from the Namsa. But of what avail are arms when men to use them are lacking? The Almān and the Namsa are very clever, but they have a small army. Hence the Government and the Sultan in Constantinople decided to send their soldiers against the Franj and especially against the Inklīz. These three governments—those of the Almān, Namsa, and Atrāk (Turks)—have made an alliance . . . not so much against the Franj as against the Inklīz . . . ; for the Franj have not taken anything belonging to the Sultan, but several months ago the Inklīz dispossessed him of Egypt and it is their intention to take Al-Baṣra and the whole of Irak away from him also.'

One of the company remarked that the Mosqūb were very numerous too, and that they wanted to drive the Sultan from Constantinople. Said An-Nūri:

'The Mosqūb are very numerous, but the tribe Rūsiya exceeds them greatly. Many kingdoms belong to the Rūsiya and they are feared by even the Persians; yet they have not liberated all of their own blood. Even the tribe of my brother Mūsa [Musil] forms a part of the Rūsiya as we do of the 'Aneze; yet his tribe must obey the Namsa. The Rūsiya are very numerous, but they are not brave. I have heard that they have been routed from their own territory by the small tribe of Yābān (Japanese). The most terrible of all the warring tribes are the Inklīz. They are very rich, yet they are covetous for new countries. Ye shall see that they will be victorious even at Al-Baṣra, not through arms but through politics. . . . 'Aqeyl [camel traders] that have come from the territory of the Hend (India) have told me that nobody keeps as good order as the Inklīz. But what credit is that to them when they take away freedom? Who of ye wants to be a *mamlūk* (serf)? We can resist the Government, but can we resist the Inklīz when they come to offer gold for our freedom?'[10]

The Bedouin conception of the earth as a whole appears to be as follows:

Both the Bedouins and the Sleyb think that at each of the earth's four corners there is, far beyond the horizon, a high mountain, half of which rests upon the land

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[9] Northern Negd, Ch. 2.

[10] Arabia Deserta, pp. 442-443.

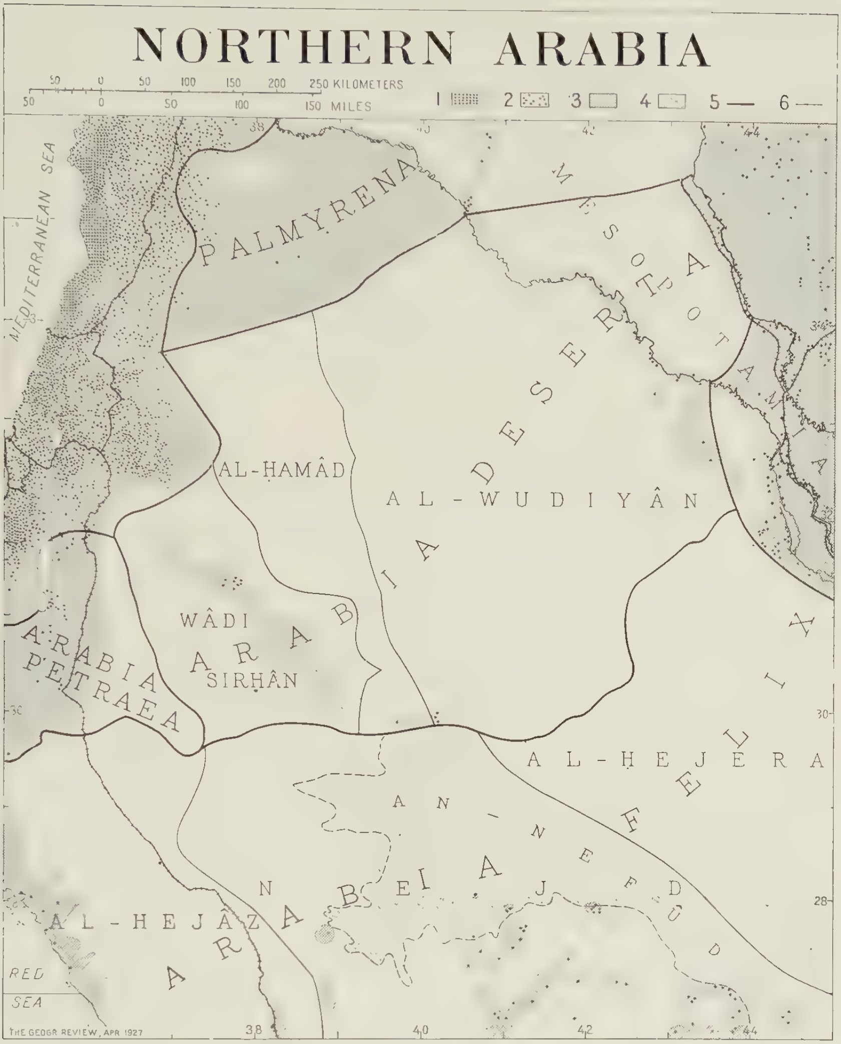

FIG. 7—Geographical regions, settled areas, and areas capable of settlement in Northern Arabia. Explanation: 1. Thickly settled areas (compiled from British General Staff maps); 2, isolated settlements (compiled from Musil's maps of Northern Arabia, Southern Mesopotamia, and Arabia Petraea, and from British General Staff maps); 3, areas for the most part capable of supporting permanent settlements; 4, sand deserts; 5, limits of major geographical regions; 6, limits of minor geographical regions. Land areas left white are deserts and steppes capable of supporting a sparse nomadic, pastoral population only. For political frontiers see maps in *Geographical Review*, Vol. 17, 1927, pp. 130, 132.

while the other half is immersed in the sea. These mountains slope precipitously toward the sea, while toward the land they project in sharp spurs, each called a nose. . . . Upon these four principal world mountains rests the sky. During the rainy season the spirits—nay, even Allāh—like to dwell near the southern mountain . . . because it is located in the inner desert; in summer they move to the northern mountain. . . .[11]

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[11] *Ibid.*, p. 264.

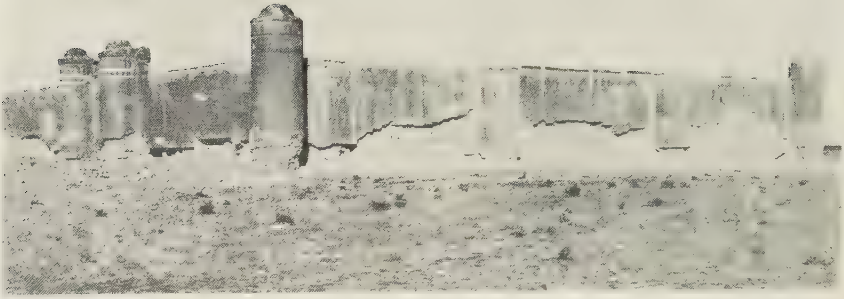

FIG. 8—Qaṣr al-Ḥēr, 44 miles south-southeast of Ar-Reṣāfa in Palmyrena. This fort was probably built by the Persians early in the Middle Ages. (Palmyrena, Fig. 21.)

EXTENT AND PURPOSE OF THE JOURNEYS

In the course of his wanderings in the desert and along the Euphrates Musil covered on camelback the total of no less than 9000 miles. Many of the regions visited had never been penetrated by any occidental explorer. We may group the virgin or nearly virgin territory opened up by him into five principal areas.

1. The largest of these is undoubtedly the area comprising much of the immense regions of Al-Ḥamād and Al-Wudiyān, extending south some two hundred miles from the post road connecting Damascus with Hīt on the Euphrates to the northern edge of Wādi Sirḥān and the fringes of the Nefūd. Early in 1909 and again in 1914 Musil explored much of this area, which, except for Butler and Aylmer's observations in the course of a rapid trip from Baghdad to Al-Jowf in 1908, was a complete blank.[12] Leachman crossed Al-Wudiyān from northwest to southeast in 1912,[13] and Miss Gertrude Lowthian Bell skirted the westernmost fringe of Al-Ḥamād in 1913. Since the war a motor and airplane route has been established across the heart of this area from 'Ammān to Ar-Rumādī;[14] and the route from Al-Jowf to An-Nejef has been traversed by Philby and Holt.[15]

2. The second area is the interior of southern Mesopotamia, visited in 1912 and 1915.

3. The third area lies for a distance of more than three hundred miles from Al-Jowf southeastward. Nolde[16] and Shakespear,[17] to be sure, had made their way through part of this area, and Musil's

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[12] S. S. Butler: Baghdad to Damascus Viâ El Jauf, Northern Arabia, *Geogr. Journ.*, Vol. 33, 1909, pp. 517–535.

[13] G. Leachman: A Journey through Central Arabia," *Geogr. Journ.*, Vol. 43, 1914, pp. 500–520.

[14] J. J. Lloyd-Williams: Re-marking the Air Route from Ramadi to Landing Ground R, *Geogr. Journ.*, Vol. 62, 1923, pp. 350–359.

[15] H. St. J. B. Philby: Jauf and the North Arabian Desert, *Geogr. Journ.*, Vol. 62, 1923, pp. 241–259.

[16] Eduard Nolde: Reise nach Innerarabien, Kurdistan, und Armenien, 1892, Brunswick, 1895.

[17] Douglas Carruthers: Captain Shakespear's Last Journey, *Geogr. Journ.*, Vol. 59, 1922, pp. 321–334 and 401–418.

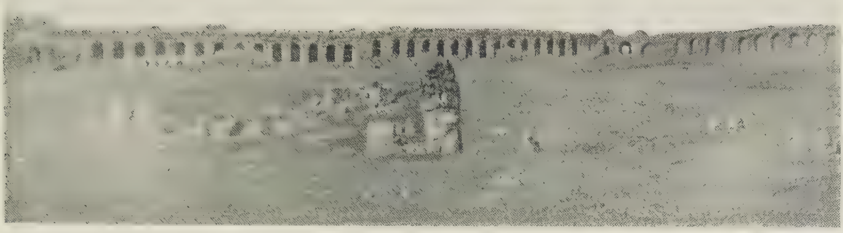

FIG. 9—The walls of the ruined and deserted city of Ar-Reṣāfa in Palmyrena. Important as early as the ninth century before Christ, Ar-Reṣāfa was destined in the early Christian centuries to become a flourishing commercial center and pilgrim shrine. (Palmyrena, Fig. 43 and Appendix VI.)

route here crossed the tracks of the various explorers who have passed from ʻIrāq to Nejd or in the opposite direction. Although a broad empty space on the map was not here broken into for the first time, this part of Musil's exploration is, nevertheless, highly significant in view of the fact that it established definitely the northeastern edge of the Nefūd.

4. In company with An-Nūri Musil wandered over a broad stretch of unknown territory on the western margins of the Nefūd between Teyma and Jauf.[18]

5. In the northern Ḥejāz in 1910 extensive lava-covered and mountainous regions south of Tebūk and west of the Ḥejāz Railway were traversed. Here Musil's only European predecessor was Wallin in 1848.[19] Finally we may add that he is the only European explorer who has traced the entire east bank of the Euphrates between Al-Fellūje, near Baghdad, and Ar-Raqqa, 25 miles northeast of Ar-Reṣāfa.

The fundamental purpose being to carry out as detailed and thorough a topographical survey of northern Arabia as possible, the regions of greatest interest were visited not only once but several times. On each expedition a trained surveyor from the Military Geographical Institute at Vienna was taken. The immense area covered and the limited resources precluded a trigonometrical survey, although an attempt was made to establish a triangulation net in southern Palmyrena in 1908. As Musil explains,

> I was obliged to base the skeleton of my map upon astronomical determinations of latitude, plane-table surveys, and detailed route traverses only. My latitudes for all the points actually visited by me are reliable, as they were either astronomically determined or directly measured by route traverse from astronomically determined points. My latitudes for points between my routes were determined

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[18] Musil's routes here lie somewhat to the east of those of Douglas Carruthers in 1909 ("A Journey in North-Western Arabia," *Geogr. Journ.*, Vol. 35, 1910, pp. 225–248) and of Miss G. L. Bell in 1913.

[19] G. A. Wallin: Notes taken during a Journey through Part of Northern Arabia in 1848, *Journ. Royal Geogr. Soc.*, Vol. 20, 1850, pp. 293–344.

either by plane-table or from precise topographical descriptions given me by various natives who sketched for me maps of regions which I could not visit in person. Such positions are of course subject to error, and many of my latitudes thus determined will have to be corrected by such future explorers as will be able to carry out astronomical observations.[20]

No attempt was made at the astronomical determination of longitudes. Longitude were reckoned from plane-table work and on route traverses.

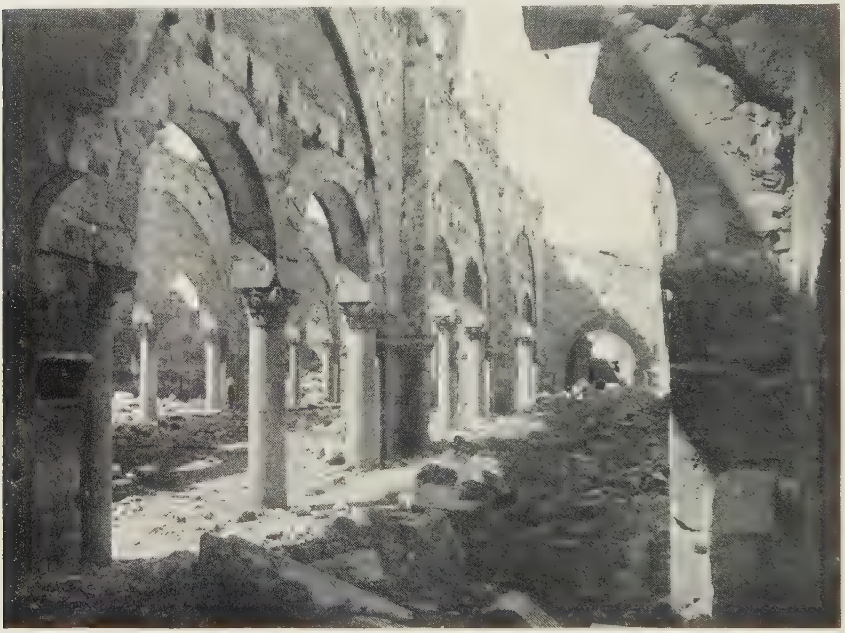

Fig. 10—North aisle of the monastery basilica of St. Sergius at Ar-Reṣāfa. An inscription states that this basilica was extensively repaired in 1093. At this time the columns and lesser arches, brought from older ecclesiastical structures which had been injured by earthquakes, were used to reinforce the larger arches of the original structure. (Palmyrena, Fig. 68 and Appendix VI.)

As we rode on camels only we soon learned the different rates of march per hour across regions of varying physiographic character. We were able to gain from this accurate data on the camels' rates of march when traveling for a considerable distance northward or southward, for then we could check our estimates of distance by the astronomically determined latitudes. This gave us criteria for plotting the route traverses in an easterly or westerly direction far more accurate than one might believe possible.[21]

The most striking fact about the resultant maps as compared with all previous cartographic representations of the region lies in the clarity and minuteness in which topographical features are represented and in the abundance of place names not only along the explorer's own route but in the intervening country. The wealth of material may be attributed largely to their author's proficiency in the Arabic language, in which he interrogated and cross-examined his guides and other natives. As among other untutored peoples, among the Arabs there are individuals with exceptionally keen topographical sense and memory. While it is not true that every nomad is so gifted, the average Bedouin being incapable of finding his way in a desert without a guide, some of the more observing and intelligent among the tribesmen can draw very accurate maps. For instance a guide in the Ḥejāz

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[20] Arabia Deserta, pp. xiii-xiv.

[21] *Ibid.*, p. xiv.

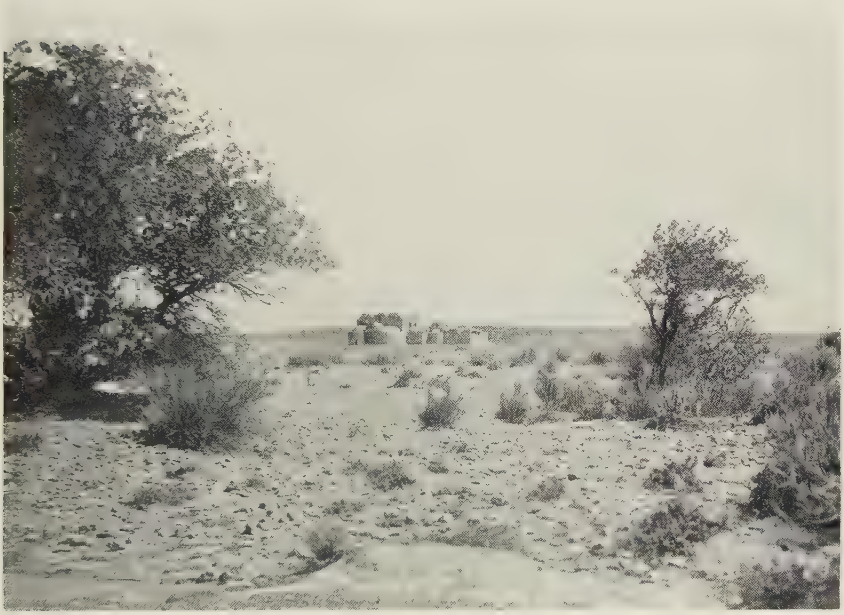

FIG. 11—The Quṣeyr 'Amra near the head of Wādi Sirḥān, 40 miles east-southeast of 'Ammān. This great building was originally constructed in the eighth century of our era as a summer residence for one of the Omayyad caliphs. The interior is decorated with wall paintings, among them one showing the rulers (including Roderick, the last of the Visigothic kings of Spain) who had been conquered by the caliph's ancestors. Discovered by Professor Musil in 1901, the Quṣeyr 'Amra was revisited by him in 1912. (Arabia Deserta, Fig. 82, pp. 343–346.)

> . . . drew a plan of the whole shore of Al-Ḥmeyẓa as far as 'Aynūna, with the various *she'ibān* [dry watercourses] and the mountains from which they run. . . . Twice I rubbed out his drawing and asked him to sketch the *she'ibān* again—on each occasion from a different side—and I thus found that he never contradicted himself. His statements as to direction and distance were accurate.[22]

It may also be remarked that a thorough knowledge of the language eliminates a not infrequent error made by travelers whose acquaintance with Arabic is imperfect—that of indicating as place names words which in reality are merely generic terms describing features of the landscape—while the possibility of mistakes in the recording of place names is also minimized.

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[22] The Northern Ḥeǧâz, p. 98.

GEOGRAPHICAL REGIONS OF NORTHERN ARABIA

Professor Musil would include the classical Palmyrena and southern Mesopotamia within northern Arabia. Regarded from the climatic, physiographic, and anthropogeographic points of view, these two regions certainly have more in common with the great plateaus of Arabia to the south than with the more mountainous and moister countries to the north, west, and east. This fact was recognized by some of the classical and Arabic writers. This "northern Arabia" in the broadest sense was divided by the classical geographers into four major subdivisions: Palmyrena and the three Arabias proper—Arabia Deserta, Arabia Felix, and Arabia Petraea.[23]

A comparison of the results of the field studies with those derived from a close and critical examination of the historical sources, revealed the striking fact that the Palmyrena and the three Arabias of antiquity coincide with certain broad geographical provinces into which northern Arabia as a whole may be subdivided. We may therefore employ the classical names to designate these geographical provinces, which will be taken as a basis for the very brief regional sketch that follows (Fig. 7).

Palmyrena

Palmyrena, although essentially a northward continuation of the dry plateaus of Arabia Deserta, is cut off from the latter by mountain ranges which attain a maximum altitude of 1380 meters;[24] it also receives a somewhat greater rainfall. Although at the present time agriculture is carried on in isolated localities only, Musil believes that the greater part of this province was cultivated in antiquity. The reason for the decline of agriculture, however, he does not seek in the theory of the progressive desiccation of western Asia—a theory for which he finds no valid evidence. He is convinced that under a strong and stable government Palmyrena might be cultivated far more widely than is now the case.

On the south this province is separated from Arabia Deserta by a strip of land known as Al-Manāẓer, "the march" or frontier zone between the land of the nomads and what in earlier days was a country of fixed settlements. Nomads, however, now penetrate through Palmyrena even to its northern border, as Musil learned to his distress in 1912, when he and his party were plundered not far from Aleppo by 120 Shammar raiders from Nejd. Indeed, although it lies close to Damascus and the other large towns of Syria and although an automobile road has recently been constructed to the ruins of

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[23] Musil's work of 1896–1902 in Arabia Petraea is recorded in his "Arabia Petraea," 3 vols. in 4, published by the Kaiserliche Akademie der Wissenschaften, Vienna, 1907–1908.

[24] Musil's map "Northern Arabia" is the first map that gives any adequate conception of the topography of these ranges.

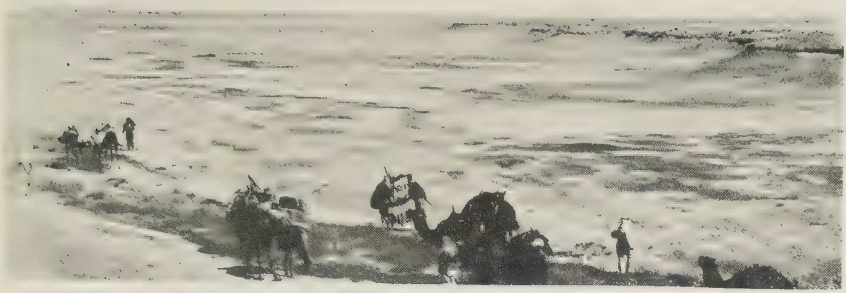

Fig. 12

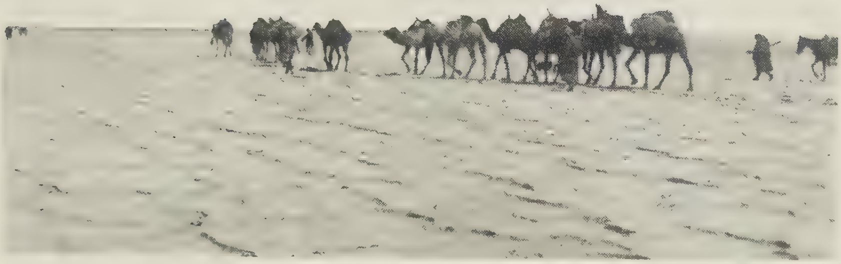

Fig. 13

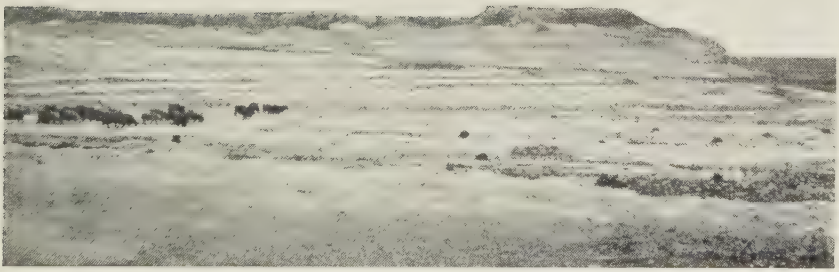

Fig. 14

Fig. 12—Looking west toward the Euphrates valley (visible in the distance) from a point in the interior of southern Mesopotamia about 85 miles northwest of Al-Miyādhīn. The valley of Al-Khfeyyān in the foreground. (The Middle Euphrates, Fig. 32.)

Fig. 13—Salina of Al-'Edeyd in the interior of southern Mesopotamia 40 miles northwest of 'Āna. (*Ibid.*, Fig. 27.)

Fig. 14—Bluffs along the eastern bank of the river Ath-Tharthār in the interior of southern Mesopotamia at a point about 36 miles west-southwest of Tekrīt. Here the bed of Ath-Tharthār is well below the level of the Tigris at Tekrīt; 30 miles farther south Ath-Tharthār flows into a salina the surface of which is 50 meters below sea level. (*Ibid.*, Fig. 21.)

Palmyra, Palmyrena for the most part is a relatively little known and somewhat dangerous country.

Of the regions under discussion Palmyrena stands second only to the alluvial plain of Babylonia in historical and archeological interest (Fig. 8). It is the only one of the regions that formed an integral part of the Roman Empire and was traversed by a network of Roman roads. The courses of some of these roads were traced in the field, and the whole network reconstructed from the scanty notices in the documentary sources.[25] One of these Roman highways led from Damascus to Palmyra along the southern base of the mountains and was marked by a line of powerful forts to which aqueducts were built from the hills. In northern Palmyrena there is the great deserted city of Ar-Reṣāfa, with its mighty walls (Fig. 9) and the colossal ruins of the basilica of St. Sergius (Fig. 10) built in the fifth century. Musil visited Ar-Reṣāfa both in 1908 and 1912 and in the latter year carried out a detailed survey of the site. He was, however, unfortunately robbed of the notes and plans made on that occasion. The photographs taken in 1912 were preserved and furnish striking testimony to the wealth and power of a city whose ruins—ghost-haunted, as the Bedouins think—now stand alone in an almost waterless plain. The problem of water supply was solved in the palmy days of Ar-Reṣāfa by the construction of an elaborate system of aqueducts and cisterns, traces of which may still be seen both without and within the walls.

Arabia Deserta

Southward from Palmyrena stretches a vast expanse of desert, the true home of the nomad from the earliest times, a land that has never been suited to cultivation. This is the Arabia Deserta of the classical writers, As-Samāwa of the Arabs, now sometimes called the Syrian, as if to distinguish it from the Arabian, desert, although historically this, if any region, is truly desert Arabia. The borders of Arabia Deserta as defined by Ptolemy and other classical writers follow certain fairly well-defined physiographic boundaries. Beginning within a few miles east of Damascus the western border runs south along the edge of the volcanic territory of the Ḥawrān and thence along the watersheds between the interior drainage basins of Wādi Sirḥān and al-Jafar to the granitic range of Ash-Shera', the Se'īr of the Old Testament. From here eastward to the northernmost point of the Nefūd sands the southern boundary follows the edge of the Wādi Sirḥān catchment basin. The northeastern edge of the dune country then marks the border as far as the head of the Wādi al-Kherr, whence its course is interpreted as following that

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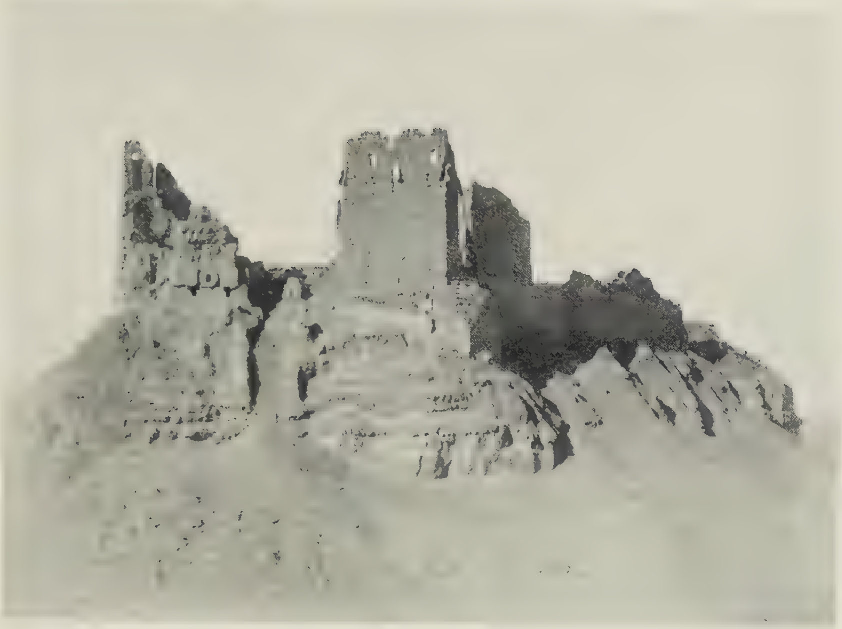
[25] Palmyrena, Appendix II.



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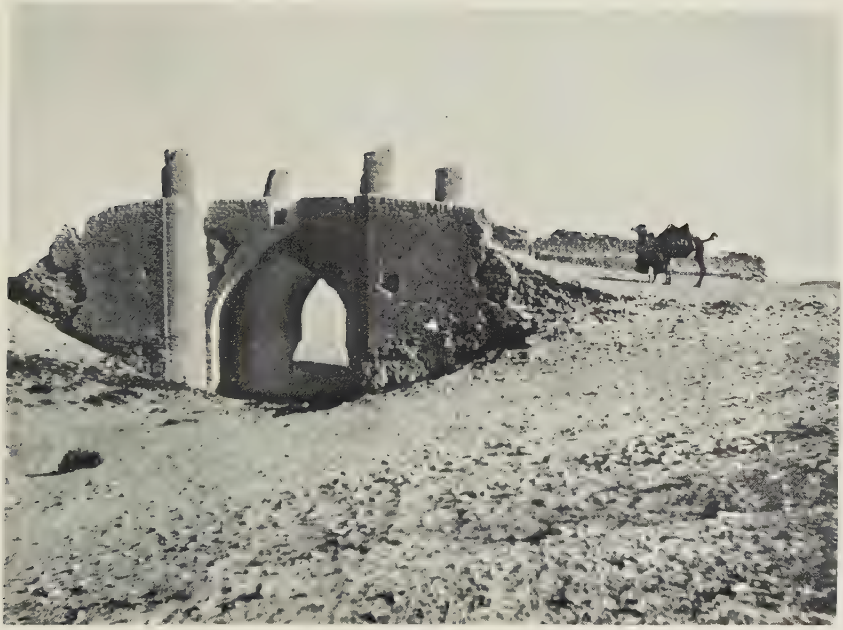


FIG. 16

FIG. 15—Castle of Ar-Rḥaba on a projection of the bluffs overlooking the Euphrates flood plain near Al-Miyādhīn. (The Middle Euphrates, Fig. 2.)

FIG. 16—Old brick bridge spanning the abandoned canal of Sa'de in the Euphrates flood plain not far to the east of An-Nejef. (*Ibid.*, Fig. 17.)

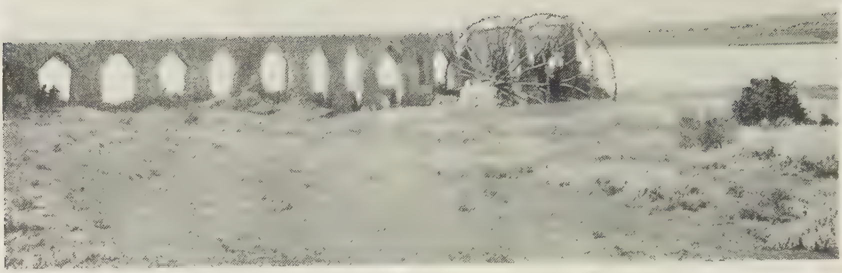


FIG. 17

FIG. 18

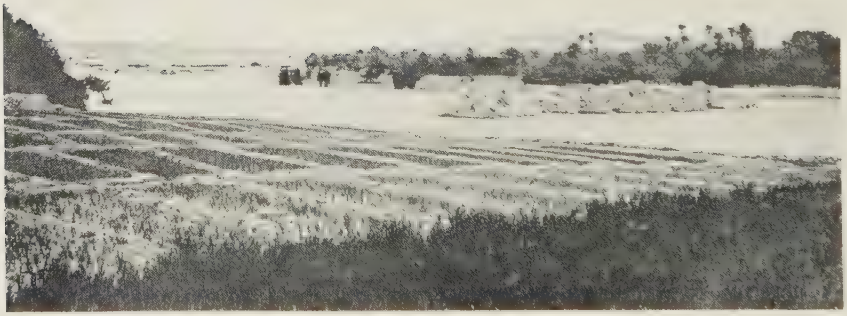


FIG. 19

FIG. 17—Water wheel on the Euphrates. The current keeps the wheel in motion; the water is thus raised in jugs attached to the rims and thence conveyed to the fields by a trough supported on the pillars. (The Middle Euphrates Fig. 9.)

FIG. 18—The island of Telbes in the Euphrates 10 miles below 'Āna. This island, strongly fortified by the Persians, held out against the Roman Emperor Julian in his campaign along the Euphrates in 363 A. D. (*Ibid.*, Fig. 48.)

FIG. 19—Cultivated fields in the foreground, the Euphrates and the island of Ana al-'Alizhe (Old 'Āna) connected with the shore by a ruined bridge in the middle distance, and bluffs overlooking the Euphrates flood plain in the background.

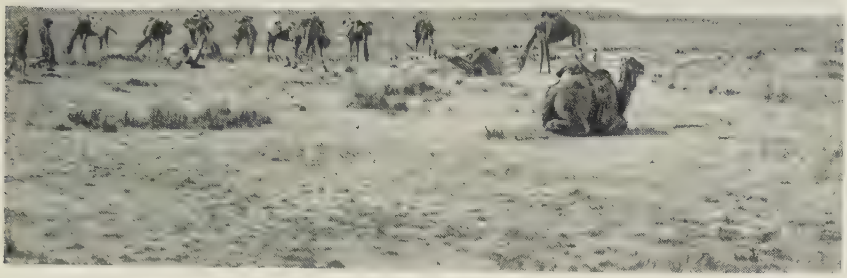
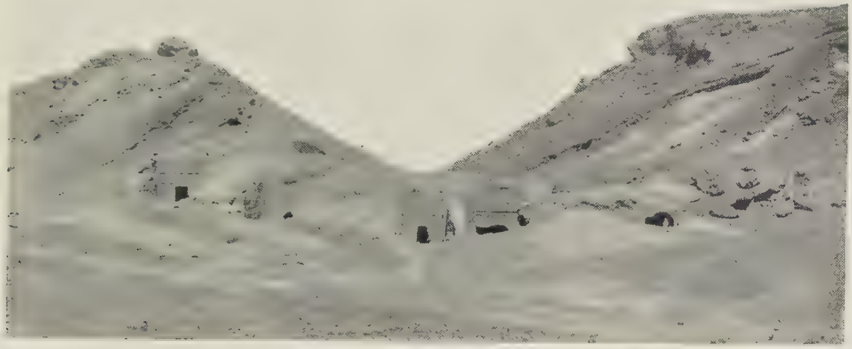


FIG. 20



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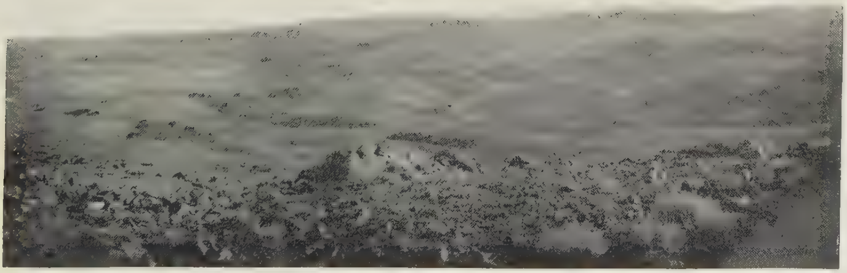

FIG. 22

FIG. 20—Typical landscape in the plateau of Al-Ḥamād. This photograph was taken not far north of Al-Jowf. (Arabia Deserta, Fig. 109, p. 451.)

FIG. 21—Nabataean tombs at the ancient Madian, 70 miles due south of Al-ʿAqaba. The now deserted city is named from the Madianites of the Old Testament (see also Fig. 1). (The Northern Ḥeǧâz, Fig. 39, pp. 111, 278–282.)

FIG. 22—Looking south over the arid, much denuded plateau of Ḥesma' from the crest of the granitic range of Ash-Shera', 35 miles south of Ma'ān. Possibly the product of the denudation of Ḥesma' formed the source material of the Nefūd sands. At one time Ash-Shera' marked the frontier of the Roman Empire. (*Ibid.*, Fig. 8, pp. 43, 258.)

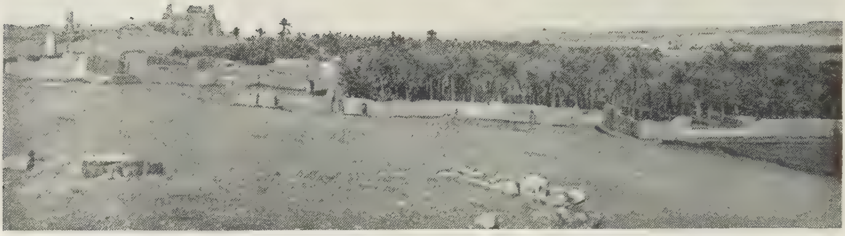

FIG. 23—The southern part of the settlement of Al-Jowf, which lies in a long narrow basin (*jowf*) where the ground water supplies moisture for gardens and palm groves (see also Fig. 24). (Arabia Deserta, Fig. 113, p. 460.)

wadi to the Euphrates, instead of running due eastward to the Persian Gulf, as some have thought. The northeastern edge of Arabia Deserta Professor Musil would place not at the Euphrates but at the Tigris, thus including the barren interior plateaus of southern Mesopotamia north of the alluvial lowlands of ʻIrāq. From the geological and physiographic points of view this part of Mesopotamia is one with the regions west of the narrow entrenchèd valley of the Euphrates.

The geographic province of Arabia Deserta may be subdivided into five lesser geographic regions: (1) the interior of southern Mesopotamia; (2) the Euphrates Valley; (3) Al-Wudiyān; (4) Al-Ḥamād; and (5) Wādi Sirḥān. A few points of special interest may be mentioned about each of these.

1. On the whole the interior of southern Mesopotamia is a monotonous steppe land (Fig. 12), varied here and there by shallow salinas (Fig. 13) and by occasional tracts where the rock salt and gypsum deposits assume curious forms. The monotony of these barren plateaus is broken, however, by a valley cutting through them from north to south for a distance of more than 150 miles. This valley contains in its depths what is very unusual in any part of Arabia, a perennial stream, Ath-Tharthār (Fig. 14), which ends in a glistening salt lake, Umm Raḥal. This lake lies on the floor of a deep hollow overlooked on all sides but the north by escarpments. Aneroid readings gave the surface of Umm Raḥal as 50 meters below sea level although it lies only 35 miles from the Euphrates at Hīt. Is it altogether impossible that there may be a connection between this singular valley and the classical legend of Tartarus, river of the Underworld? The names at least are similar.

2. The Euphrates has deeply incised its valley beneath the plateau level (Figs. 12, 18, 19). Its flood plain supports a long but somewhat broken chain of cultivated fields and meadows, forming a world apart from Arabia Deserta proper, as far as human life and activity are concerned.

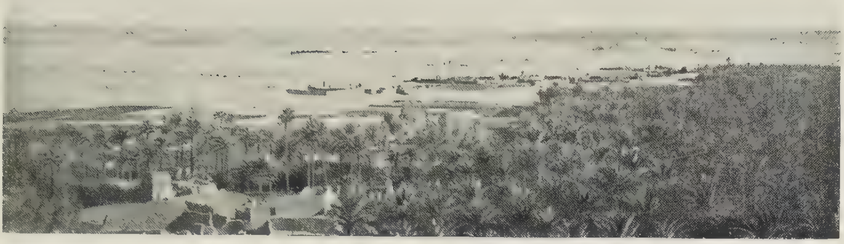

Fig. 24—The northern part of the settlement of Al-Jowf. The escarpment in the background is the southern edge of the plateau of Al-Ḥamād. (Arabia Deserta, Fig. 114, p. 461.)

In antiquity the main highways along the Euphrates ran along the left bank. Here was the Royal Road of the Persian kings which Xenophon followed with the Ten Thousand; and it was down the left bank that the army of Julian the Apostate marched[26] during the Persian campaign of 363 A. D. Furthermore, most of the towns of antiquity stood on the left bank. Now, however, this side of the stream is generally abandoned and almost unknown; the highways and towns are confined to the right bank, where, owing to numerous tributary valleys approaching the main stream, communications are, by nature at least, rendered much more difficult than on the opposite side. The reason for this maladjustment of man to topography lies in the fact that in the Middle Ages nomads from Central Asia—Turks and Mongols—infested the interior of Mesopotamia and directly menaced towns and roads east of the Euphrates. The Euphrates came to be the fortified frontier (Fig. 15) of the states and settlements of Syria, and the population retreated to the side that was the more protected even though less favored by its local topography.

The economic and social condition of many of the settlers along the Euphrates was not very happy at the time of Professor Musil's visit (1915). At one place he remarks that most of the hamlets were owned by absentee landlords, wealthy citizens of Kerbela, Baghdad, and even of Aleppo, who had either bought the land outright from the Dleym tribesmen, the original owners, or had simply taken possession, driving the Dleym out, building some huts, setting up water wheels (Fig. 17), and letting the land to the peasants from other localities. The tenant was caught between the upper and the nether millstone: the landlord, who demanded one third of his crops, and the tax collector, who squeezed him in the most heartless manner, often leaving him no more than a bare sixth of the crops "on which the poor

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[26] As Appendixes to his "The Middle Euphrates" Musil reconstructs Xenophon's and Julian's routes on the basis of his detailed studies in the field.

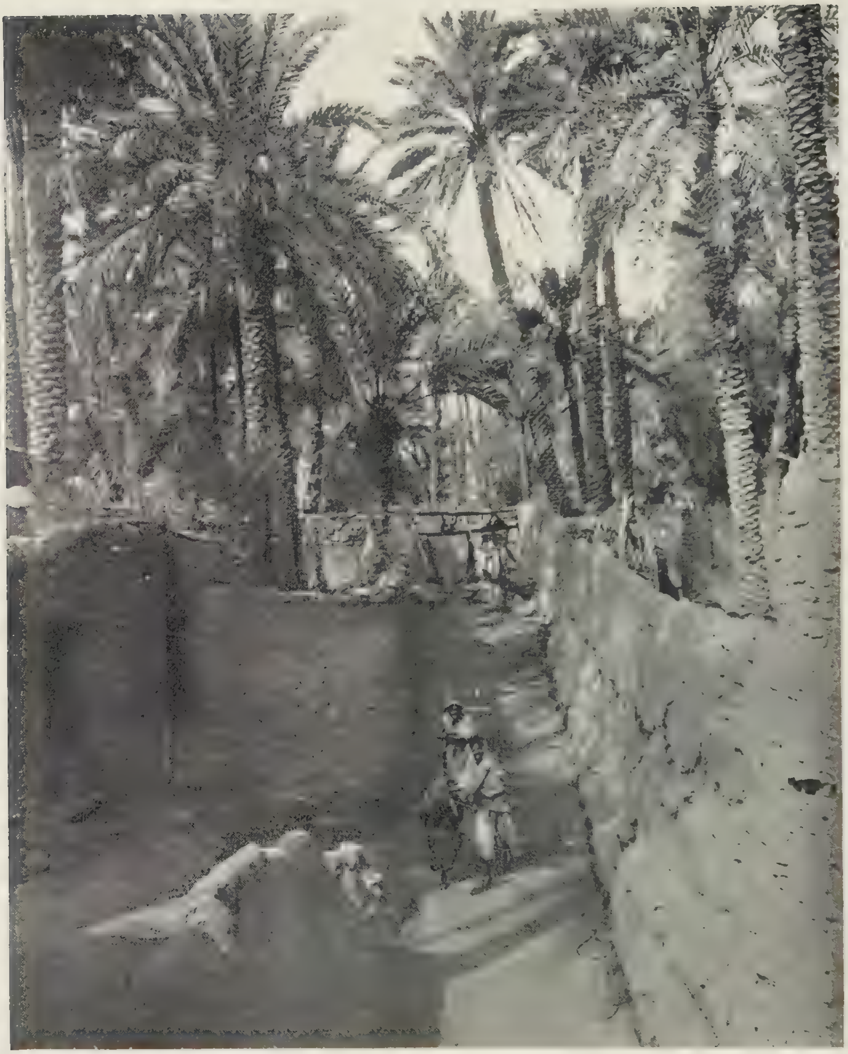

FIG. 25—Draw well in the gardens of al-Jowf. The water for irrigation is hoisted out of the wells in hide buckets raised by camels or cows. (Arabia Deserta, Fig. 117, pp. 466, 473.)

fellow had to work with all his family, his cattle, and implements for a whole year."[27]

3 and 4. Physiographically Al-Wudiyān and Al-Ḥamād together form a single plateau. The somewhat indefinite line separating them corresponds essentially with the northern part of the divide between the watershed of the Euphrates and the watersheds of the great interior drainage basins of inner Arabia. It would appear that the headward erosion of the wadis which reach the Euphrates has sculp-

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[27] The Middle Euphrates, Ch. 11.

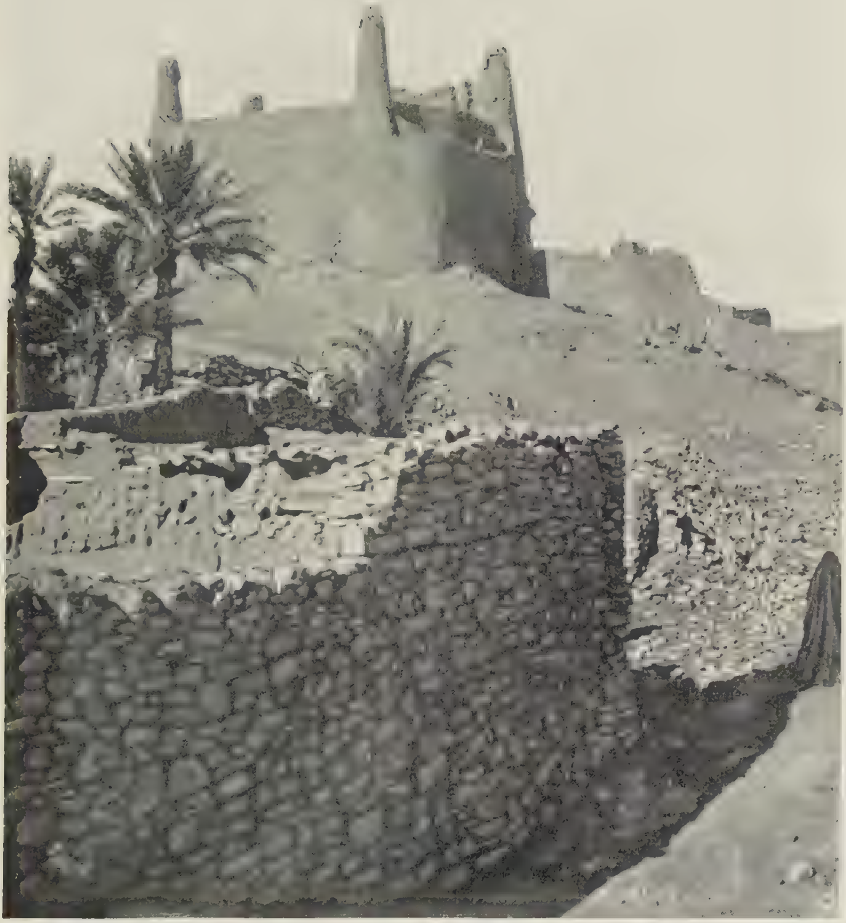

FIG. 26—The Mãred tower, or fort, at al-Jowf, from the south. See Fig. 23. (Arabia Deserta, Fig. 112, pp. 458, 470–472.)

tured out "The Valleys" (*al-wudiyān*) but that it has not as yet progressed far enough upstream to dissect the entire surface of the plateau—the western, as yet undissected, part forming the smooth plain of Al-Ḥamād (Fig. 20). Both Al-Ḥamād and Al-Wudiyān are dry regions with few wells or water holes, and they afford very slender pasturage for camels. No wonder the Rwala and other tribes migrate in winter southward beyond the confines of this lean country into the sands of the Nefūd where green shrubs and grasses for their herds are more plentiful.

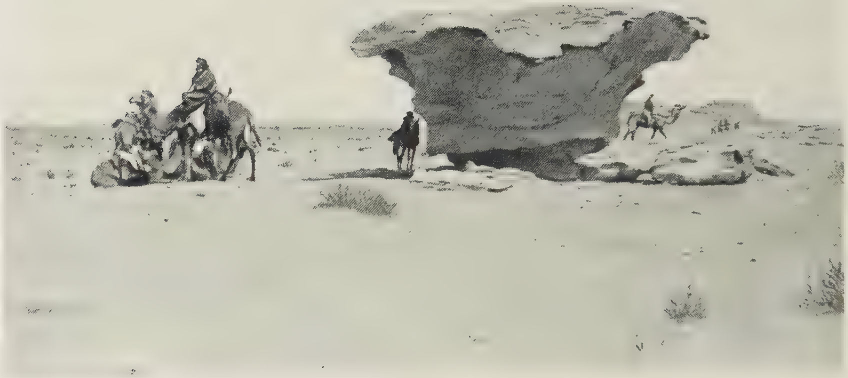

FIG. 27

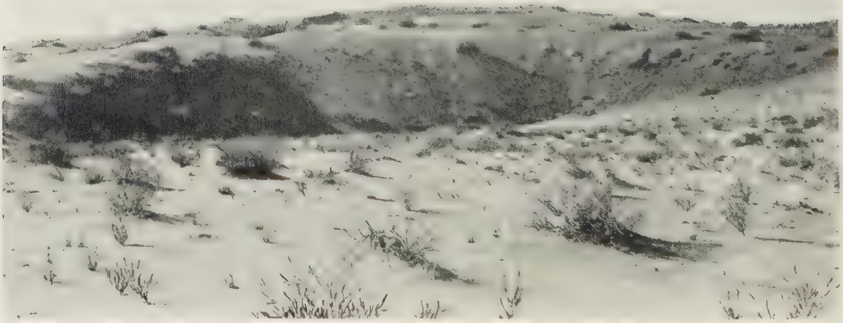

FIG. 28

FIG. 27 The Kheyf Hajal, an erosion remnant in the depression of Al-Jūba 20 miles east of Al-Jowf near Al-Qāra. Despite the action of wind-blown sand, inscriptions carved on this rock about the time of Christ are still legible. (Arabia Deserta, Fig. 42, pp. 195–196.)

FIG. 28—A *farshe*, or funnel-shaped pit scoured out by wind action in the Nefūd desert. The photograph shows the relatively abundant vegetation of the Nefūd sands, which renders this region a favorite winter pasture land of the Rwala and other tribes. (*Ibid.*, Fig. 30, p. 153.)

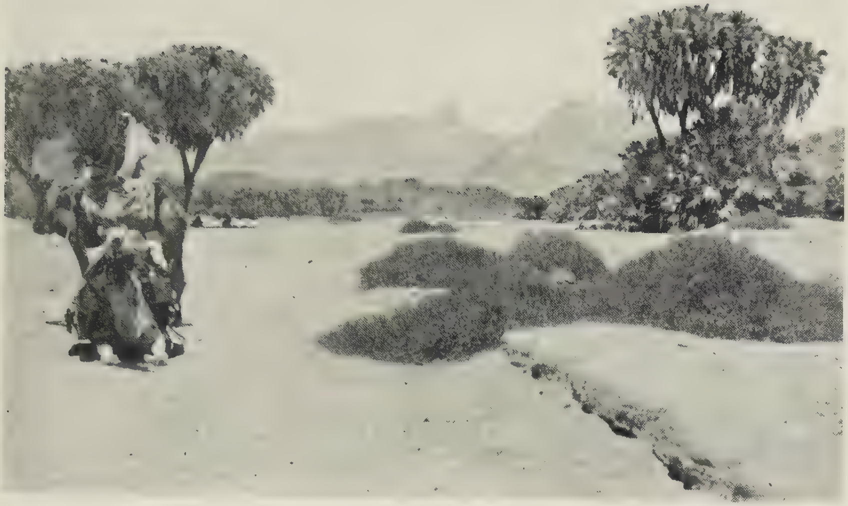

FIG. 29

FIG. 30

FIG. 29—The rugged coast range of the northern Ḥejāz (Mt. Ad-Dubba) as seen from the bed of a wadi to the west. (The Northern Ḥeǧâz, Fig. 58, pp. 141–142.)

FIG. 30—Surroundings of the well of Al-Madhkūr in the desolate coast ranges of the northern Ḥejāz, about 40 miles southwest of Tebūk. (*Ibid.*, Fig. 73, p. 189.)

Al-Ḥamād falls off gradually westward. Unlike the corresponding basins in Arabia Felix the interior drainage basins of Al-Ḥamād are deserted and uninhabited, the run-off finding its way into saline swamps. The western boundary of Al-Ḥamād beyond these basins is formed by almost impassable lava-covered uplands extending from near Damascus southward as far as Wādi Sirḥān. Between the northernmost lava tract and the mountains of Palmyrena a "narrow passage connects the fertile fields of Damascus with the wastes of Arabia and is the most convenient gateway for the migrating Bedouins, whose camels thus avoid the steep rocks of the northern range and the sharp edges of lava which is piled high in Tlūl-al-'Iyāth."[28] From the earliest times this natural gateway has been of supreme historical importance. An extraordinary feature of the water supply of Al-Ḥamād is thus described:

> There is not a single spring in the plains of the Ḥamād and almost no wells of spring water. The Arabs draw their water from natural basins or depressions in which rain water gathers and forms larger or smaller pools. Where there are no such natural pools, many artificial reservoirs are to be seen, frequently measuring thousands of square meters in area and as many as three meters deep. The excavated clay forms wide banks in which are left large openings through which rain water flows into the pools. The chiefs who directed these gigantic feats of engineering displayed great ingenuity in thus securing for their herds the water which is so indispensable to them in these regions, where otherwise they could not find pasture. Moreover, they also saved the pasturage adjoining the natural waters for the times when the water in the artificial pools evaporates. Many thousands of diligent hands were necessary to excavate these basins. I am inclined to believe that the work was not done by the Bedouins, or camel raisers, but by the *shwāya*, who raise goats and sheep. Perhaps they were helped by the inhabitants of the settlements south of Damascus, who drove their herds in late autumn to the eastern desert in order to save their crops. They could pasture in the desert from the first rains in November until May, provided they supplied themselves with the water necessary for their sheep and goats; and hence they may have excavated the artificial rain pools for this purpose. At the end of May or the beginning of June, when the last of the water had evaporated, they would return to their settlements, where, meantime, the harvesting had begun and their herds could thus graze in the stubble fields. The same method could—nay, ought—to be employed even now by a powerful government which has the welfare of the settlers at heart.[29]

On the south Al-Ḥamād overlooks the basin of Al-Jūba or Al-Jowf in which lies a group of palm groves and settlements (Figs. 23–27).

5. Wādi Sirḥān is a long, narrow depression covered here and there with saline incrustations and treacherous quagmires and affording little pasturage for the Bedouin herds. There are, however, a number of wells along the margins, and in the north-central part several small settlements near Chāf (Kāf). Except for the towns and villages along the Euphrates these are the only permanent settlements

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[28] Arabia Deserta, p. 380

[29] *Ibid.*, p. 411.

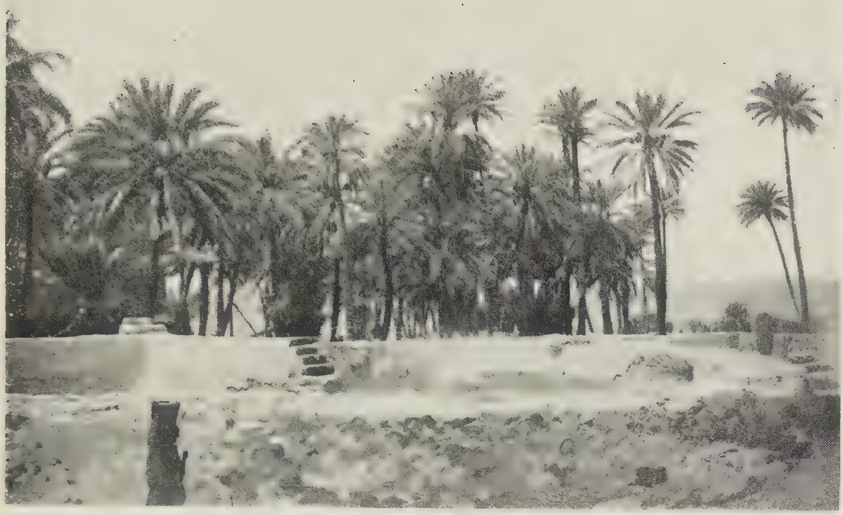

FIG. 31

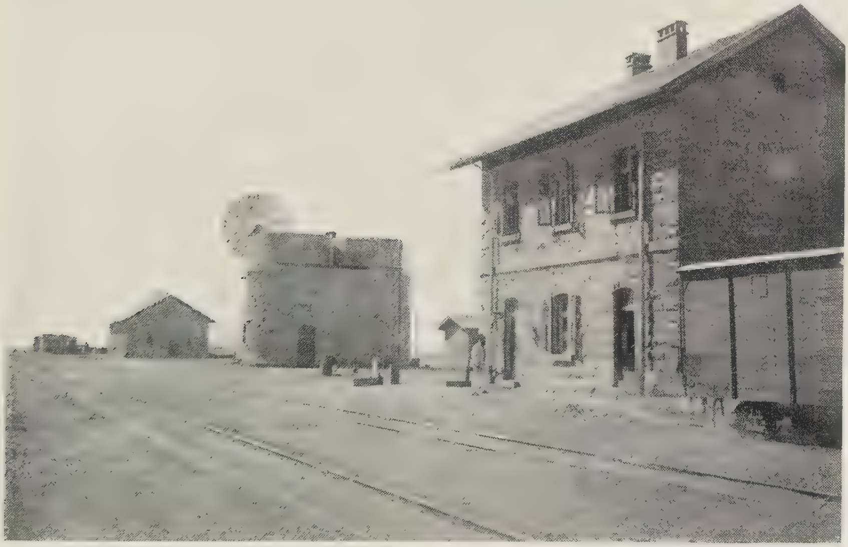

FIG. 32

FIG. 31—Reservoirs at Tebūk. These reservoirs, on a slight elevation, are fed by an abundantly flowing spring; from them the water is conducted by irrigation ditches to the neighboring gardens and palm groves. (The Northern Ḥeǧâz, Fig. 64, p. 167.)

FIG. 32—Railway station, water tanks, and other buildings of the Ḥejāz Railway at Tebūk. (*Ibid.* Fig. 86, p. 237.)

within the limits of Arabia Deserta. The settlers here are dominated by the Bedouin tribes; members of the ruling family of the Rwala own most of the palm trees from which they receive annually a fixed proportion of the crops.

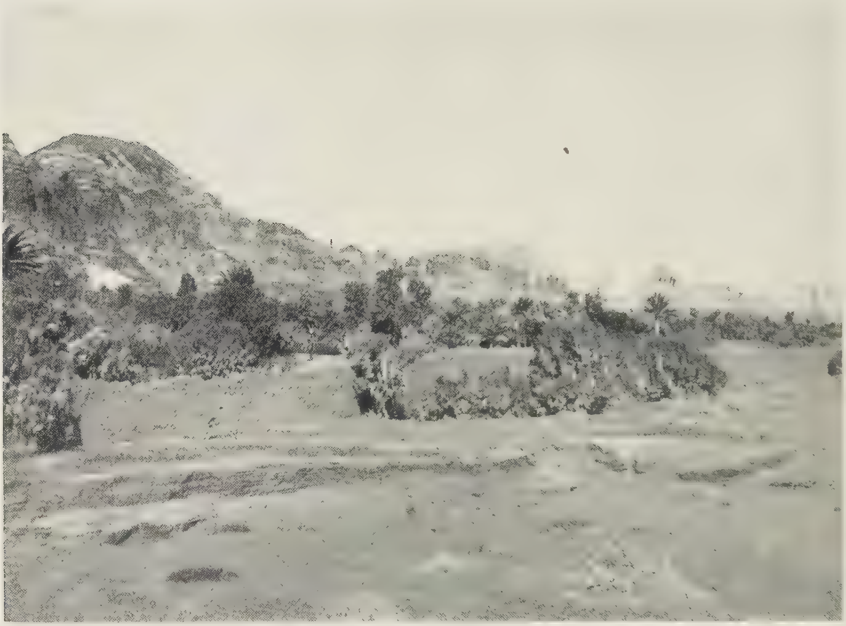

FIG. 33—Oasis about seven miles north of Al-'Ela, on the Ḥejāz Railway in the northern Ḥejāz. A sandstone mountain capped with lava rises in the background. (Northern Neǧd, Fig. 33.)

Arabia Felix

The entire Arabian peninsula south of the borders of Arabia Deserta was known to the classical geographers as Arabia Felix, and the name was not, as is sometimes supposed, confined to the Yemen. Only the northern portions of Arabia Felix were visited by Professor Musil and are of concern to us here.

Justification for the name Arabia Felix in contradistinction to Arabia Deserta is found in the character of the country as a whole. Whereas there are almost no permanent settlements in Arabia Deserta, Arabia Felix is essentially a land of oases in which there are clusters of scattered hamlets and villages (Fig. 7). These oases lie in basins of varying size separated from each other by stony deserts, sand dunes, rough, lava-covered uplands, or utterly barren mountains. Between the oases the land is as sterile and heartbreaking as anything to be found in Arabia Deserta, but totally waterless country nowhere is as extensive, except, perhaps, in the great desert of the south, far beyond our present sphere of interest.

Most of the basins are entirely enclosed by higher ground. The run-off is protected from evaporation by sand and gravel, and hence there is available at the lower levels a supply of water which, when tapped by wells or brought to the surface by the crude hoists operated by donkeys, cows, or camels, is sufficient to irrigate fields and palm groves.

In the northern part of the Ḥejāz, or the western mountainous zone of Arabia Felix, small settlements are found where some of the wadis making their way down towards the Red Sea emerge upon the coastal plain (Fig. 29). East of the coast ranges is a line of interior drainage basins threaded by the old Pilgrim Road to the Holy Cities and by the modern Ḥejāz Railroad (Fig. 32). Here also there are a few small settlements—notably Tebūk (Fig. 31) and Al'Ela' (Fig. 33)—but, apart from these, most of the northern Ḥejāz is a barren, mountainous country (Fig. 30) occupied by nomads of a distinctly less noble type than the rovers of the plains of Arabia Deserta. Northwest of Tebūk lies a large arid plateau country, Ḥesma (Fig. 22) in which sculpturing by the wind has produced fantastic forms out of the soft sandstone strata. It is possible that the sands of the Nefūd desert to the east have been derived from the disintegrated strata of Ḥesma.

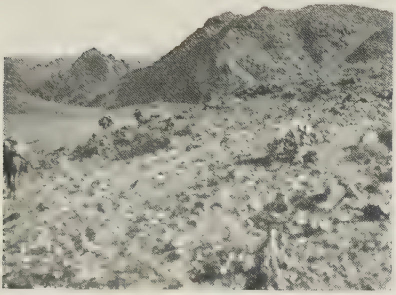

FIG. 34

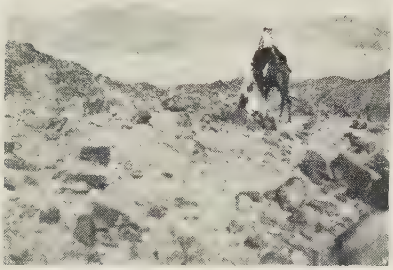

FIG. 35

FIG. 34—The Ḥelwān hills in northern Nejd 45 miles southeast of Teyma. (Northern Neǧd, Fig. 40.)

FIG. 35—Al-Misma, a range of rugged peaks in northern Nejd about 80 miles west of Ḥāyel. In the middle distance is a sandy tongue of the Nefūd desert which runs south between Al-Misma and ʽErnān (see Fig. 7). (*Ibid.*, Fig. 43.)

Central and eastern Arabia Felix is now known as Nejd. Professor Musil's explorations in northern Nejd brought him into country of three distinct types: tracts of sand dunes, rugged mountains, and a vast stretch of plateau extending northeastward towards Mesopotamia.

The sand deserts of the Nefūd and Ad-Dhana are not the utterly inhospitable wastes pictured by the imagination, but in the winter season are covered with fairly abundant vegetation (Fig. 28) much sought for by the Bedouins from the desolate stony uplands to the north. On the whole the sands seem to be moving from west to east, Ad-Dhana being formed, perhaps, by sand blown from the Nefūd proper. At all events the sand deposits in Ad-Dhana are here less thick than those farther west.

South of the Nefūd, the jagged ranges (Figs. 34, 35) of the Shammar country run north and south and are separated by broad intermontane basins where there are small patches of cultivated soil. The most important oasis and settlement here is that of Ḥāyel, the Shammar capital.

The divide between the Euphrates watershed and the interior drainage basins of Nejd follows the northeastern edge of the Nefūd. From this divide to the Euphrates the general regional slope, as in Al-Wudiyān, is northeastward. Structurally this part of Arabia Felix, known as Al-Ḥejera, is probably a southeastward continuation of the plateau of Al-Ḥamād and Al-Wūdiyan. There is, however, a remarkable difference in the drainage pattern and detailed relief, which sets this region off from Al-Wudiyān and justifies, on topographic grounds, its inclusion in Arabia Felix rather than in Arabia Deserta. Instead of the elaborate development of parallel consequent valleys trending northeastward which are so characteristic of Al-Wudiyān, to the southeast of Wādi al-Kherr there is a series of parallel, presumably subsequent lowlands trending northwest and southeast. These appear to have been eroded along belts of softer rock leaving between them plateaus bordered by well defined scarps. The subsequent lowlands drain northwestward and southeastward into two great consequent valleys, Wādi al-Kherr and Wādi al-Baten (known as Wādi ar-Rma' in its upper course). Numerous wells are found in the lowlands, but there are no permanent settlements.

THE COLONIZATION OF EASTERN GREENLAND

ESKIMO SETTLEMENT ON SCORESBY SOUND

Ejnar Mikkelsen

First European Contacts

EUROPEAN colonization of Greenland began in 983 when Eric the Red, exiled from Iceland for a period of three years, headed westward over the ocean towards some skerries which had been sighted a few years previously by his countryman Gunnbjörn. Encountering ice Eric turned to the south until he rounded the southern promontory of the huge land mass and, still following the ice towards the northwest, found an opening amongst the floes, which allowed him to penetrate towards the coast. Compared with his former home on the bleak and desolate northern part of Iceland Eric found the new land good and inviting. He explored several of the fiords, chose that he considered best, and took land after the old Icelandic manner, calling it Greenland and proclaiming himself master over all he saw. When his time of outlawry had been served he persuaded other Icelanders to join him. The colony throve. About the year 1200 when it attained its highest development several thousand people lived in the so-called Western and Eastern Settlements. There were some 280 farmsteads, 16 churches, even monasteries and nunneries. A bishopric was founded, the see being the present Igaliko, the old Gardar, and here, as well as at Brattahlid, the farm of Eric the Red, many ruins have been found, among others of the cathedral and the houses of the farmstead itself, which shows that at one time there must have been a very considerable occupation in cattle raising and sheep farming.

The subsequent fate of the settlers is, however, shrouded in mystery. Communication with Europe became less and less frequent, the last official sailing being in 1410. Thrown entirely on its own resources, the old Norse colony gradually declined,[1] whether owing to degeneration caused by intermarriage, by a deterioration of the climate, or for other unknown reasons is uncertain; but there seems to be no doubt that about the beginning of the sixteenth century the last survivors had succumbed to the more powerful native inhabitants of the country, the Eskimos.

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[1] For a recent discussion of the decline of the Eastern Settlement see Dr. William Hovgaard's article "The Norsemen in Greenland: Recent Discoveries at Herjolfsnes," *Geogr. Rev.*, Vol. 15, 1925, pp. 605–616.

Beginning of the Modern Era

The almost legendary history of the Norse colonists, however, for a long time gave rise to discussion and conjecture, and several voyages of exploration were undertaken without finding any trace of the old settlers. Then came Hans Egede. At the initiative of this zealous missionary some merchants in Bergen formed a company for the purpose of trading with the Eskimos, Egede aiming thereby at an opportunity of carrying on missionary work among the lost Norsemen. In 1721 he landed on the site of the present settlement of Godthaab and found a large number of Eskimos—all comparatively wealthy, dressed in sealskin and furs, each man the owner of a kayak, each family of a umiak (woman's boat). Of meat they had plenty, of blubber and seal oil more than they could possibly use, of furs for barter large quantities—but of the Norsemen Egede saw no trace except the ruins: the people themselves had vanished. Undaunted, he transferred his hopes. Here was a rich field for missionary work amongst the heathen Eskimo, who knew civilization and its blessings only through intercourse with the whaling crews that had followed in the wake of the voyages of exploration.

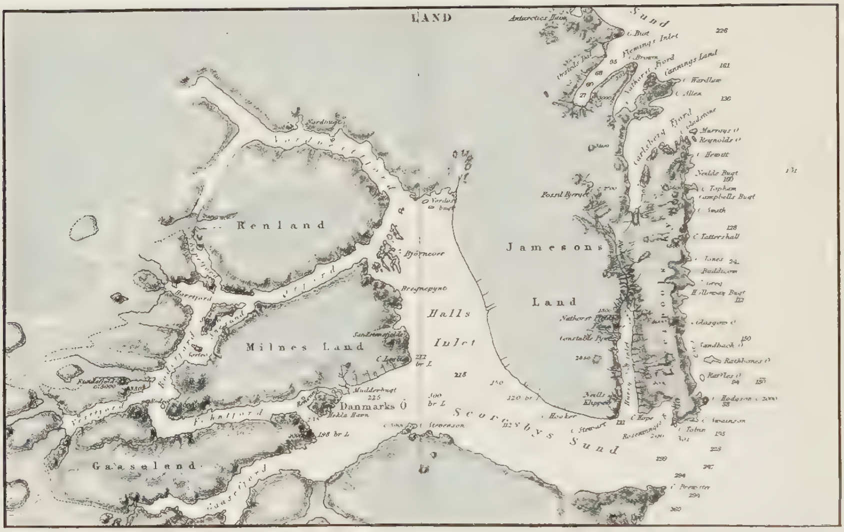

FIG. 1—Scoresby Sound reproduced on a reduced scale from the Royal Danish Hydrographic Office Chart No. 147, 1902. The western and eastern limits are the thirtieth and twentieth meridians respectively; the northern and southern limits the seventy-second and the seventieth parallels.

So Hans Egede remained, but the company soon ran into financial troubles. Seven years after it had been started, the company's liabilities and assets were taken over by the Danish king, Frederik IV, who infused it with new life and attempted to regulate the dealings of the whalers with the natives. But decrees, however well framed, were difficult of enforcement. Conditions were not improved when the Danish king sent out a military governor followed by soldiers and Danish colonists, the colonists being convicts! Naturally this move was not a success. The ex-convicts quarreled and fought and died; the soldiers mutinied; the conduct of the whalers was increasingly licentious. Every man's hand was against his neighbor.

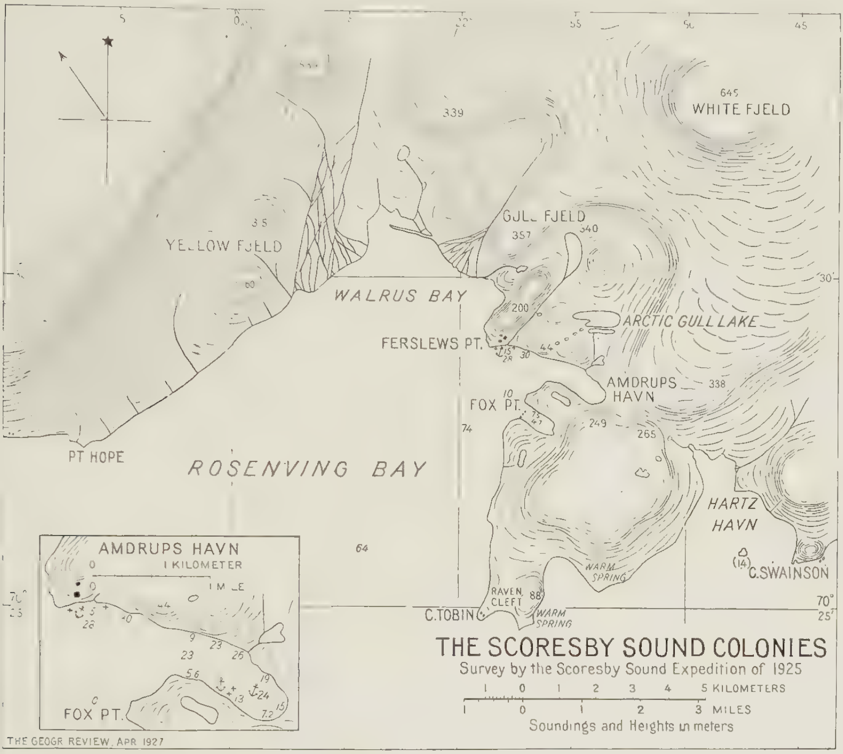

FIG. 2—Map of the site of the new Eskimo colonization of Scoresby Sound. Scale approximately 1:200,000. The inset shows Amdrups Havn, where headquarters is situated, on a larger scale.

But interest in Greenland had been effectively roused in Denmark. It was realized that if the Eskimos were to be saved and the mission succeed, other measures must be resorted to; wherefore the country, with the official approbation of all interested nations, was closed in 1774. The Danish government undertook control of communications and exclusive trading rights. The Royal Greenlandic Trading Company was formed, and no one was permitted to set foot in the country without the special consent of the Danish government.

GREENLAND TODAY

All that happened 150 years ago, and Greenland of today is very different from Greenland of old. The inhabitants, now about 15,000 in number, are mostly living in some 70 small settlements scattered along the coast, which is divided into 15 districts, each with a larger central settlement and administrative headquarters. In these centers are located the main stores and warehouses, with a church and a school in each and in most a hospital; but a store is also found in all the smaller settlements, where a native teacher or minister is resident.

The inhabitants themselves are changed from primitive, nomadic hunters to a more or less locally bound population dependent on the government stores. This development has its regrettable consequences, as more people live in a place than can be supported by the game it furnishes. Furthermore, the number of seals caught has decreased alarmingly, partly for this reason, partly because of the introduction of firearms, but principally because of the ruthless slaughter of seals on their breeding grounds along the Greenlandic east coast by Norwegian sealers. In spite of the care that has been taken, the population has become so pauperized, that a large yearly grant is necessary to keep the country going. The government, however, is taking steps to introduce new means of livelihood, for instance, cod fishing and sheep raising, both of which seem in a fair way of success.

In the meantime the work of changing the inhabitants from a tribe of the stone age to a civilized race has almost been brought to an end. The educational work is now nearly all carried on by the Greenlanders themselves under the supervision of some few Danes. Greenlanders are being trained to take over the trading stations; while all internal administration of the different settlements and to some extent the affairs of the country as a whole are managed by Greenlanders elected by common vote of the adult population.

The closing of the country and the establishment of monopolized trade and shipping were dangerous but necessary expedients that have been justified by results. A state monopoly, however, is not an ideal form of government, and it has probably outlived its usefulness; but under its strict protection the Greenlanders have been given time and freedom to adjust themselves to new conditions of life, and quite a new race of people has been created under its care.

The Status of the East Coast

In this peaceful but slow development of a nation a new factor was unfortunately introduced by the Danes themselves in 1921, in the probably uncalled-for extension of the monopoly to the whole of the east coast of Greenland, where only one Greenlandic settlement existed (where a monopoly had been established before) and where the coast is protected by barriers of ice. Its effect was to arouse the wrath of Norwegian sealers who thought themselves—

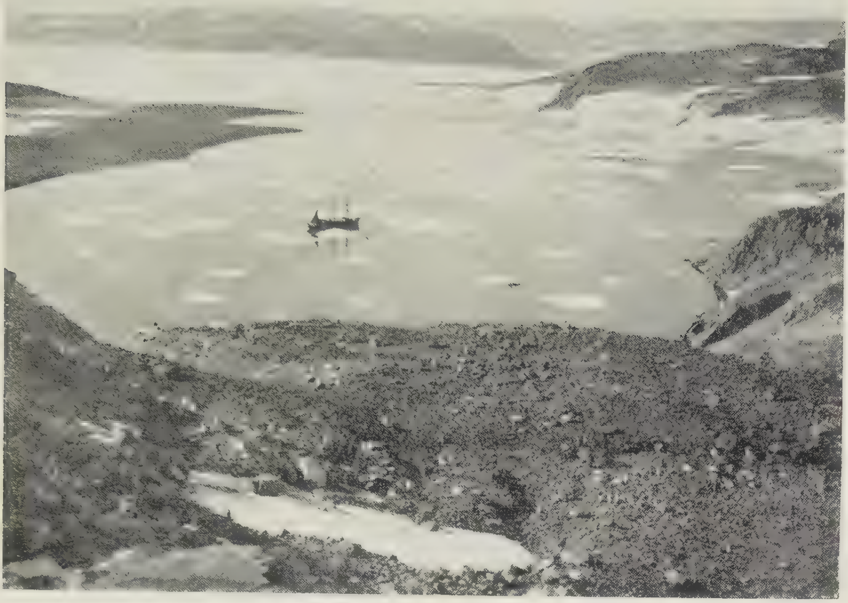

FIG. 3

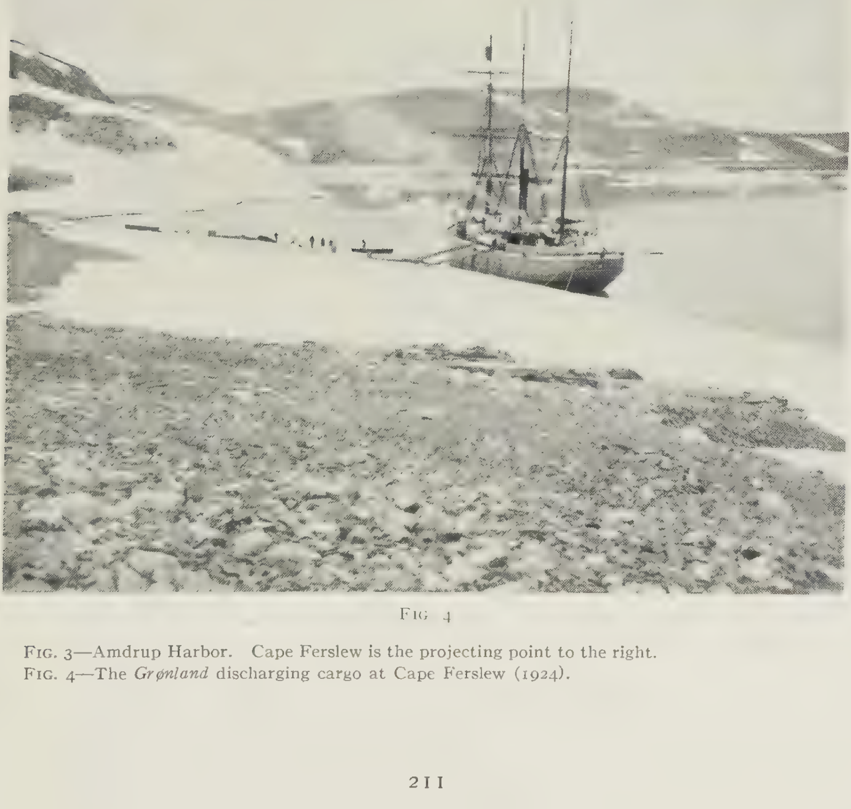

FIG. 4

FIG. 3—Amdrup Harbor. Cape Ferslew is the projecting point to the right.
FIG. 4—The *Grønland* discharging cargo at Cape Ferslew (1924).

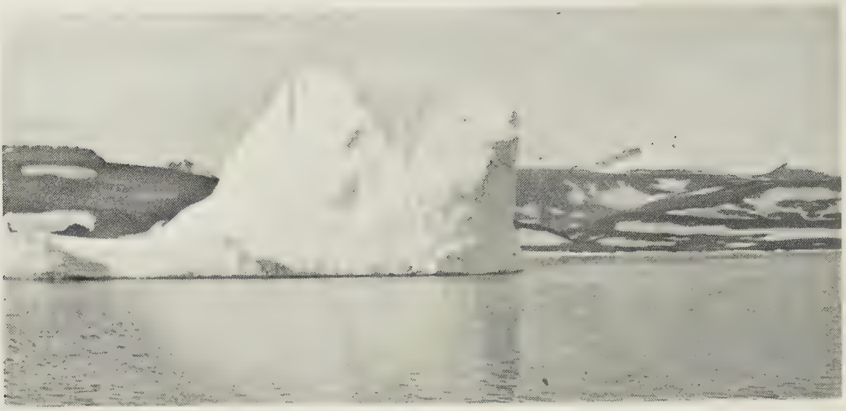

FIG. 5

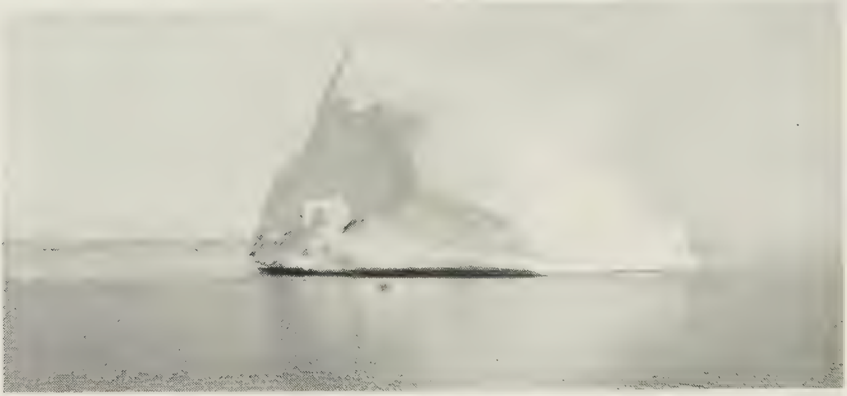

FIG. 6

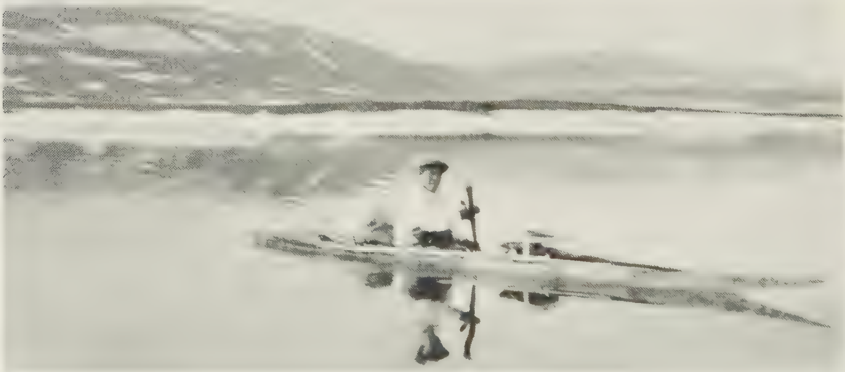

FIG. 7

FIGS. 5 and 6—Examples of icebergs encountered off Scoresby Sound.
FIG. 7—A Greenlander skimming along in his kayak off Point Hope.

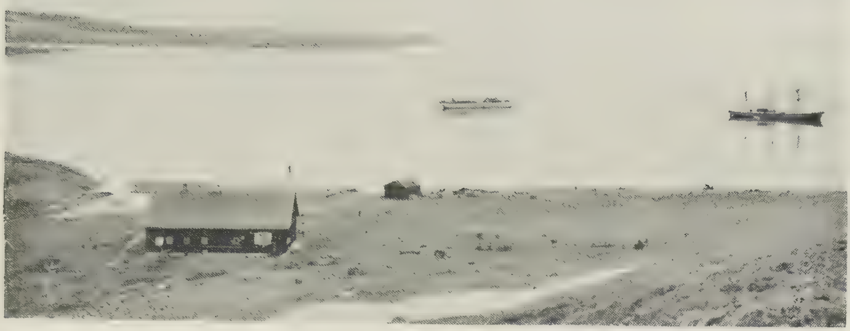

Fig. 8

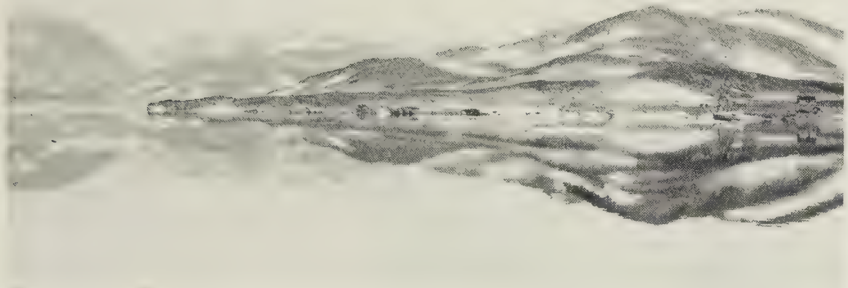

Fig. 9

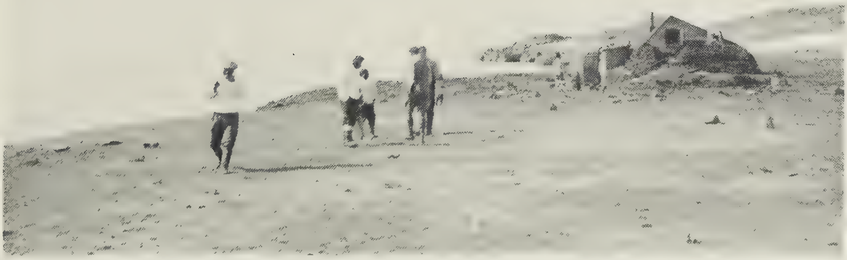

Fig. 10

Fig. 8—The *Pourquoi-Pas?* and *Gustav Holm* off the settlement at Cape Ferslew.
Fig. 9—Cape Ferslew with the settlement on the extreme right.
Fig. 10—The level land at Point Hope.

though I believe without good reason—deprived of a hunting territory. Their government naturally took the part of the sealers; much political discussion ensued, followed by a treaty—and then trouble began in earnest!

Neither Norwegians nor Danes nor, least of all, Greenlanders themselves were satisfied. The treaty gave the sealers legal rights which they had not enjoyed before. Of most serious import is the right to establish themselves in permanent stations on the east coast of Greenland, whence they can hunt seals in hitherto protected territories and breeding grounds—to the absolute ruin of the Greenlanders, for whom the seal is everything. It is to be hoped, however, that the Norwegian sealers will realize the obligations of a superior race and avoid taxing the seal herds more heavily than already is the case. As far as we know, no steps have as yet been taken by the sealers to avail themselves of their full rights under the treaty.

This development, however, made imperative the establishment of a settlement on the east coast of Greenland as far north as possible, to protect the economic interests of the more southerly Greenlanders. Such a settlement would at the same time give the Greenlanders from the entire country a much needed opportunity for expansion and for a continuation of the happy primitive existence of their forefathers. This possible development was taken into consideration while framing the treaty, and in case Scoresby Sound should be colonized by Eskimos the whole of this huge district would automatically become a monopoly under Danish government administration.

In consequence, the writer took up a plan on which he had been working for more than ten years, namely the transfer from the inhabited parts of Greenland of some families who were willing to move to the rich hunting grounds in Scoresby Sound, now uninhabited but formerly the seat of a numerous Eskimo population. With the disinterested assistance of a large Danish newspaper, the *Ferslew Press Syndicate*, sufficient public subscriptions were obtained to warrant the undertaking of the enterprise.

The Colonization Expedition Sails

On July 10, 1924, the day after the treaty was signed, everything was ready for the start of the expedition. Our ship, the *Grønland*, left Copenhagen with outfit and provisions for 22 men for 16 months, with all the materials necessary to build a small settlement on the shores of Scoresby Sound, and with everything needful for the support of ten to twelve Greenlandic families for three or four years. It was difficult to find room for all in the ship: the deck cargo was piled high, the small boats being lashed down on top of the building materials; but fortunately the weather was fine while crossing the

Atlantic. After a short stay at Iceland, where we filled our bunkers and took four ponies on board, we headed due north, hoping to be able to sail direct to Scoresby Sound. Nor were we disappointed. On the third day after leaving Iceland we entered the pack ice, which proved to be only some 60 miles in width where the *Hekla* on Ryder's Expedition in June, 1891, had found the pack five to six times as broad.[2]

We then had in plain view the rugged but beautiful mountains of Greenland. The floes were scattered, and it was an easy matter to force a way through the outer barrier, which so often causes the navigator trouble and anxiety, and the farther we penetrated into the pack, the more scattered it seemed to be. Only 22 hours after entering the ice, we reached the open coast water, passing huge icebergs—one we measured rose 70 meters above the water line—and came into Scoresby Sound, exactly 14 days after our departure from Copenhagen.

DIFFICULTIES WITH ICE

We had expected that the bay ice in Scoresby Sound would have been broken up and drifted out to sea under the strong outgoing current, but we found to our regret that this was not so. On the contrary, an immense ice sheet stretched fast and solid from coast to coast. While awaiting the break-up we visited Cape Brewster, a breeding place for immense numbers of sea fowl, whence the prospective settlers will be able to get an unlimited supply of birds. Of other game we saw much: seals in the water popped up their heads wherever we went; bears roamed along the edge of the ice; narwhals swam in schools—the animal life of the sea and its borders was very rich.

We had made fast alongside the ice in a small bight formed between the unbroken ice and Cape Tobin, ready to go on when the ice should break. The line of breakage, however, came so far in the fiord that we became aware of it only by the rapid narrowing of the pond in which we had taken refuge. To let go our moorings and get under way was no more than a matter of minutes, but the ice moved quicker. It closed up all openings, caught the ship in its grip, and held it there while a small floe was driven with irresistible force towards our stern. The ship seemed doomed, but we could only wait and listen for the crunch of the ice, the grinding along our sides, the splintering of wood, and rending of heavy iron. Then the floe took our stern, the ship was thrown over on her beam end, something snapped, she righted herself—but rudder and rudderpost were gone. Events, however, turned out better than might have been expected. By dint of much labor we brought the ship into a large opening between the ice and the land, where dangers from floating ice or rocky coast were comparatively small. But our plans had to be entirely revised: instead of having our vessel wherewith to explore for the best situation, we had now to trust to luck. And luck followed our trail!

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[2] *Meddelelser om Grønland*, Vol. 17, 1895, p. 362.

The Headquarters Site

After the vessel had been saved I left her to investigate the conditions towards the upper end of Rosenving Bay. Walking over land I found en route numerous relics of the former inhabitants: ruined huts, tent rings wherever on a projecting sand spit there was room enough for a tent to be raised; stone fox traps—in fact, everything proved that great numbers of Eskimos had lived here in former times. And, furthermore, we found that for which in particular we were looking: an excellent harbor with a good site for the settlement. On the northern shore was a broad level plateau protected by low, rounded mountains from the northern winds, full open to the south: the river, which had cut itself down into the plateau, came from some large glacial lakes far inland and could never run dry. I decided to establish the center of the settlement here, and in all my later travels along the coasts of Scoresby Sound, I never saw a more likely spot.

At Ferslew Cape, as we christened the point, the water was deep right inshore so that we could moor our vessel alongside and, using our large wooden beams and rafters as gang planks, could take our cargo ashore direct. While unloading was in progress and the carpenters were beginning work on the central building which was to house the administration, store, church, etc., I set out westward with our motor boat to find suitable sites for the colonists' houses.

Plant and Animal Life

On this voyage I was particularly pleased to find large numbers of walrus wherever we went, also many bears and seals and large flocks of geese and ducks: in short, our motor boat trip showed us a surprising amount of game, which still is only a fraction of what a Greenlander will see, skimming along the same coast in his light and silent kayak.

On this trip we reached Cape Stewart, a splendid, fertile spot, with grass waving in the gentle breeze, butterflies flitting from flower to flower, and bees humming as at home on a warm summer day. Even a beehive, small, but filled with delicious honey, was found.

At Cape Stewart our geologist discovered a small seam of coal, and coal was later found at Cape Hope, which will provide the settlers with good and sufficient fuel. Thus may be fulfilled Scoresby's prediction: "From the apparent great extent of the coal formation in

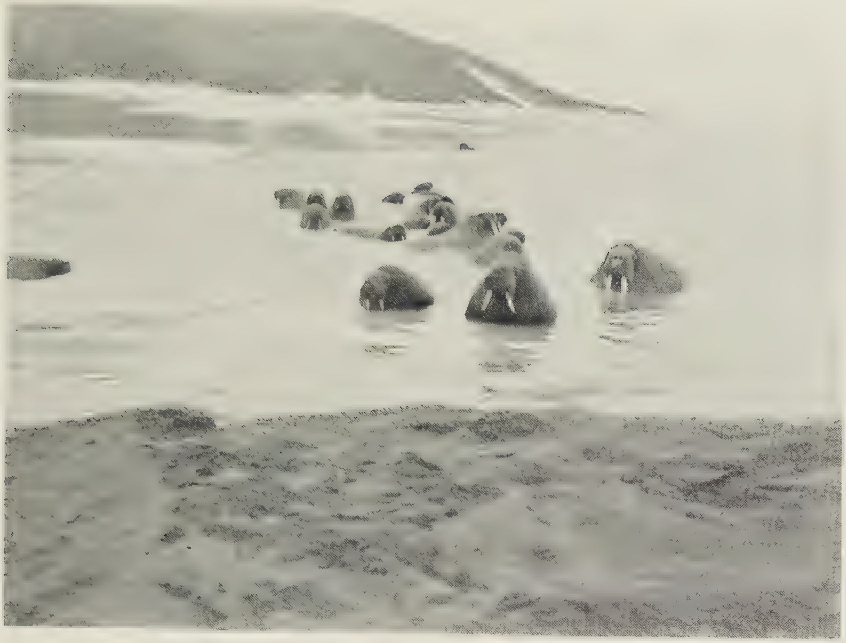

FIG. 11

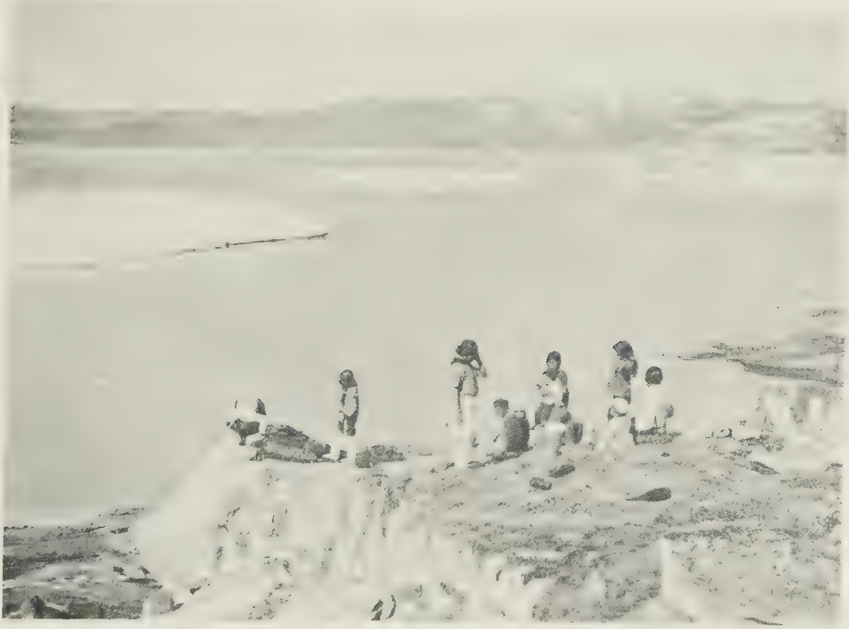

FIG. 12

FIG. 11—A herd of walrus. Game is abundant in Scoresby Sound.
FIG. 12—Women and children at Cape Tobin.

Jameson's Land, it is highly probable that it abounds in beds of coal, and if this shall prove to be the case, it may, at some period, become useful to man."[3]

After a short visit to the Fame Islands, sheltered and warm, a nesting place for great numbers of eider ducks, we headed homewards again encountering, as did the Amdrup expedition, a large number of musk oxen.[4] It is a constant matter for surprise that this huge animal can exist in a land which, according to the prevalent idea, is devoid of vegetation—but the ice-free borders of Greenland support considerable vegetation. About Scoresby Sound heather covers very large areas, and the blueberry thrives well wherever shelter is found. Dwarf birch and willow are seen all over the country, also flowers—potentillas of different kinds, saxifrage, arctic poppies—altogether our botanist found more than ninety species; then there is the grass. To quote again from Scoresby: "The vegetation in Jameson's Land is superior to any thing that I could have expected in such a latitude. About the hamlet [at Cape Stewart], the ground was richly clothed with grass, a foot in height; and more inland, my Father, who explored this country to a great extent, discovered considerable tracts that might justly be denominated *greenland*, patches of several acres, occurring here and there, (according to the testimony of Mr. Scott, surgeon of the Fame), 'of as fine meadow-land as could be seen in England.' "[5]

Sites for Colonists' Dwellings

Our intentions were to scatter the huts of our prospective colonists over as long a coast line as possible in order to give the hunters larger opportunities. We hoped in this way to be able to counteract the intelligible but regrettable desire of a people, living in such a solitude as here in Greenland, to gather round the store, whereby their economic status suffers, the number of people exceeding the capacity of the sustenance space.

To decide where to build the houses was easy enough, but to get the materials transported to the selected spots was considerably more difficult. I took this business in hand myself, towing the heavily loaded boats by the motor boat. Although the ice, drifting backwards and forwards with the strong current, frequently threatened to crush us, we escaped mishap. The materials for some eight houses were eventually carried out and deposited at the selected spots: four

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[3] William Scoresby, Jr.: Journal of a Voyage to the Northern Whale-Fishery; including Researches and Discoveries on the Eastern Coast of West Greenland, made in the Summer of 1822, in the ship Baffin of Liverpool, Edinburgh, 1823, p. 409.

[4] There is an excellent description of the ovibos in Søren Jensen's report "Mammals Observed on Amdrup's Journeys to East Greenland 1898–1900," *Meddelelser om Grønland*, Vol. 29, 1907, pp. 1–62; reference on pp. 27–61.

[5] Scoresby, *op. cit.*, pp. 214–215.

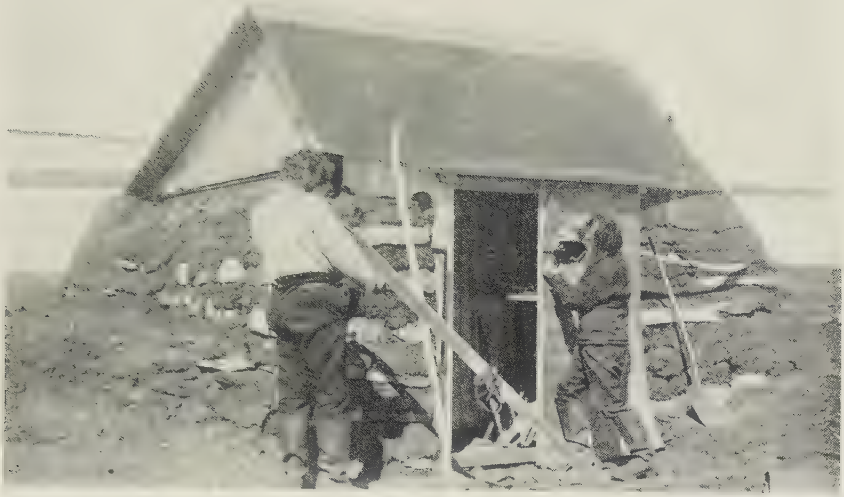

FIG. 13

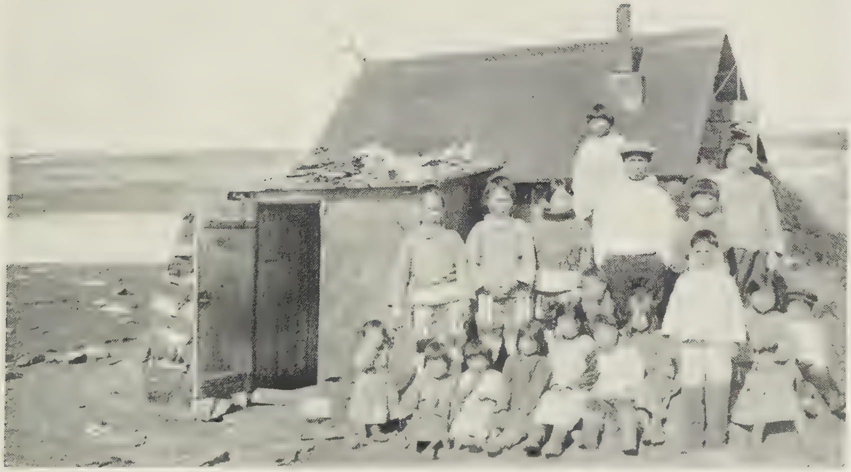

FIG. 14

FIG. 13—Building one of the settlers' huts.
FIG. 14—The settlers at Cape Hope. Two hunters are absent.

houses at Cape Stewart, two houses at Cape Hope, and two at Cape Tobin. In our endeavors to find good sites we were guided by the ruins of the old Eskimo villages.

But before we had finished this task, autumn was upon us: gales began to blow, snow fell, and in calm nights the ocean froze over so that it was difficult to force a boat through the ice. The grass withered, the leaves of the willow turned yellow, the birch deep red—a splendid sight but a warning. While we had been transporting materials for the houses, work at the center went on apace: the large house was so far finished that people could live in it, the small warehouse was built and filled with the four years' supplies. In the first week of September we were engaged on our last tasks—the putting in order of everything at Cape Ferslew and the preparation of instructions for those who were to remain behind. On board everything was ready for sea: we had only to wait for a gale to open the dense packed ice outside Scoresby Sound.

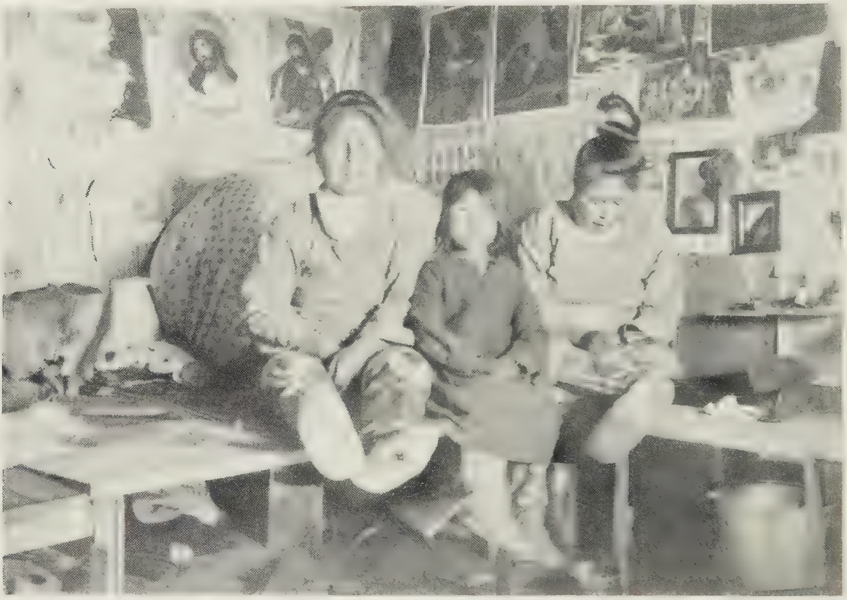

FIG. 15—The interior of a settler's house.

SAILING CONDITIONS ON RETURN

The gale came—a howling norther: now or never we had to try the most hazardous task I have ever undertaken. Conditions were about as bad as they possibly could be. The new ice was thick. Of steering gear we had none except a large oar on our quarter-deck, by means of which we hoped to be able to control our vessel in open water; but it had never been tried, and in pack ice it would of course be absolutely useless. We went slowly, as in the beginning we had to steer our vessel exclusively by means of the propeller, and it took six hours to reach Cape Tobin, where in a large channel of open water we proved our 30-foot oar useless and let it slip overboard. Half an hour later we were firmly beset in the ice and drifted with it three days without being able to extricate ourselves. Then it opened in a narrow lane leading out towards the open ocean. By ramming the ice with the bow of the ship at exactly the right angle and with the right speed we managed to steer our course, but often in turning a sharp angle the whole crew had to jump out on the ice and, by means of long ropes made fast to the end of the jib boom, check the vessel round.

Fig. 16—Healthy children.

It was hard work, dangerous too and exciting; but nine days after leaving Amdrup harbor we reached the open ocean and caught a gale that enabled us to steer our vessel southward with sails alone. The following day we saw the bleak northern coast of Iceland and reached a comparatively safe port in Skagabay. It was, however, quite impossible to repair the vessel here, and after having rigged some kind of jury rudder—by means of which we could steer our vessel in fair weather—we once more trusted to fair weather and fortune. But fair weather is rare at that time of the year; gales blew continually, and to maneuver the ship was out of the question. We drifted eastward towards the coast of Norway, and, once more favored by luck, the gale breaking at the right moment, reached the port of Molde. Here, having had excitement enough, I engaged a tug to take us to Copenhagen.

Work at the Settlement

Nearly a year later we had news from Scoresby Sound through the well known French explorer and scientist, Dr. Charcot, who on board the *Pourquoi-Pas?* was cruising in the polar ocean and shaped his course for Scoresby Sound to see whether my men were in need of assistance. On August 1, 1925, the *Pourquoi-Pas?* anchored outside the settlement to a hearty welcome by six of our men, the seventh, our geologist, Mr. Bierring Petersen, having died during the spring.

One month later our own vessel came into port, and my comrades could look back upon a well finished piece of work. To the last detail they had executed the instructions given them. A couple of days after we had left, all but one man went to Cape Stewart to rebuild the ruined storehouse of the Danish expedition of 1892, so that it could be occupied by two families of settlers. Two more houses were built in the same place.

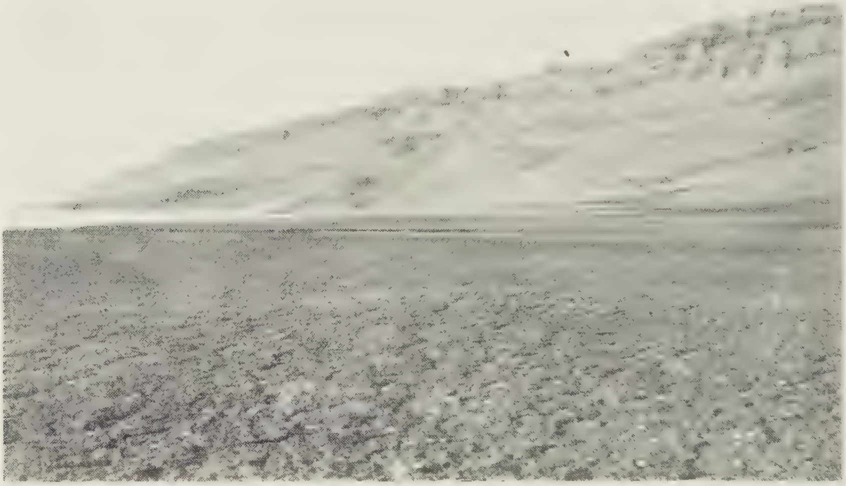

Fig. 17—Fossiliferous strata on the west coast of Hurry Inlet.

Strong gales delayed return to the main station for some time, and when they succeeded in getting back winter began in earnest. Snow fell continually, the houses were lost in it, and even the makeshift observatory, which the astronomer ought to be able to reach at any time, was often difficult to find. After about two months of confinement to the settlement it became light enough for sledge trips to be undertaken. My comrades used the time well and drove their teams far away out over the ice with good scientific results. One of the most interesting discoveries was that of warm springs on Cape Tobin, the water of which maintained a constant temperature of 62° C. One of these springs had its outflow at the water's edge and created a space of open water even in the heart of winter, in the neighborhood of which was found a very rich animal life—seals and walrus in the water, bears and foxes along its edge, and in the early spring numberless birds.

The spring of the year comes quickly in the far north when once the sun has returned. Our men, however, had no leisure to enjoy the fine weather. Some colonists' houses still had to be erected and banked with sod and stone. Before the summer had drawn to an end, everything was ready to receive the new inhabitants, and only then did the carpenters get time to follow up their various interests. One excavated several old Eskimo ruins; another engaged in horticultural experiments, and, although his results were anything but startling, he was a proud man when he presented his comrades with the first radishes grown in Scoresby Sound.

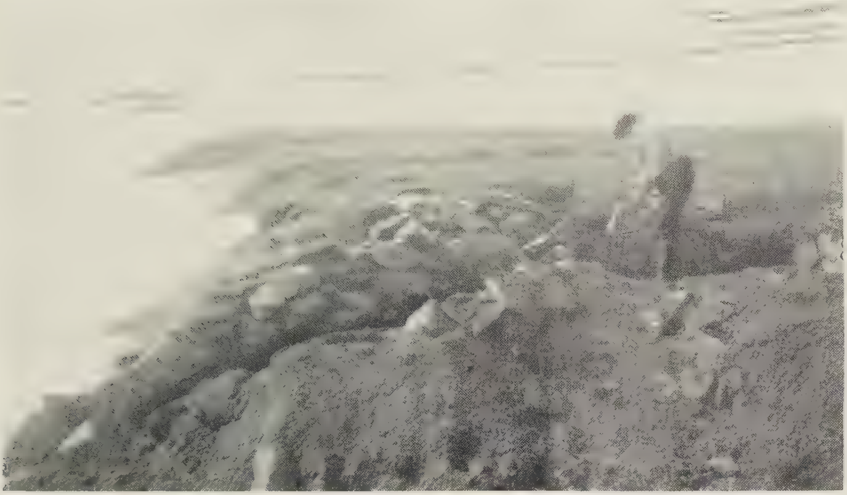

FIG. 18—Excavating an old Eskimo hut.

THE COLONISTS ARRIVE

At last, on September 2, our old ship, repaired and rechristened *Gustav Holm*,[6] came rolling into the roadstead outside the settlement, borne onwards by broad swells from the ocean, where there was no vestige of ice. And with the ship came the settlers, brought from Angmagssalik to a place which their legends tell them is a land of untold wealth. Ninety in all they were, old and young, and many children, every one eager to see the new home. They lost no time in getting their large umiaks into the water and to shore where they ran about, shouting, laughing, rolling themselves in the luxuriant grass, taking possession of the land.

The fires of the settlers flamed high in the calm nights, their meat pots were stuffed with steaming meat, and as quickly as emptied filled afresh; all was joy and contentment. The light kayaks shot over the water on the lookout for seals, while a couple of experienced men went hunting inland for musk oxen with strict orders to shoot only two—enough for the first day's consumption. The women were occupied with domestic duties, fixing up their tents as in their old homes; while some few families had already moved into the new and clean houses—small when measured by our standards, palatial buildings in the eyes of a Greenlander. The daily routine had begun, and the settlement was turned over to the representative of the Danish government: our work was done.

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[6] Named after the well known explorer of eastern Greenland and founder of the settlement at Angmagssalik, Captain Gustav Holm, R. N.

The colonization of Scoresby Sound had, however, aroused interest in various quarters, and the French government placed the vessel *Pourquoi-Pas?* at the disposal of Dr. Charcot for a cruise to Scoresby Sound in 1926. He headed north in July, and I had the pleasure of accompanying him as the guest of the government. As in the two preceding years, we met with no difficulty in the pack ice, which was passed in less than 24 hours, and we were once more in Scoresby Sound, arriving there at the same time as the Danish government steamer which came with necessary supplies.

First Year of the Settlement

We found everything in the best of order. But the first months in the new settlement had been difficult enough, as the settlers most unfortunately had brought with them from Angmagssalik a regrettable influenza, which took the life of four grown people, while sapping the strength of the rest, so that the men at first had been disinclined to hunt. This spell of inactivity lasted till about the new year, with the future of the settlement hanging in the balance. But the amount of game in Scoresby Sound is overwhelming; and once the men had begun to hunt, nothing could stop them. At the time of our arrival, all traces of the sickness and the consequent depression had long been extinct. We met only happy, healthy people, enthusiastic over the country, which had given them much more meat than they could possibly eat, and for a handsome surplus of valuable fox and bear skins they had obtained what is exceedingly scarce among Greenlanders—ready cash.

The manager of the settlement, Mr. Johan Petersen, formerly for more than 25 years manager in Angmagssalik, spoke of the country and its future in glowing terms. There was considerably more game of different kinds than he had known elsewhere in Greenland; salmon, trout, arctic cod, halibut, and the angmagset (a small fish of the salmon order), so valuable for the Greenlanders, swarm in the waters. Huge rookeries on some newly discovered islands back of Rathbone Island gave the settlers a welcome addition to the ample meat fare in the form of an unlimited supply of birds and eggs. In wintertime the hunt gave good results, as open water, even at that season, seems to reach comparatively far into Scoresby Sound, passing very close to Cape Tobin, and approaching within short distance of Cape Hope and Cape Stewart.

Good as conditions have been in the first year, it is probable that they will be even better in the future when the Greenlanders acquire a greater knowledge of the fiord and its hunting places. Finally, it must be borne in mind too that the present settlers have only barely touched the coast, while there are hundreds of miles of hunting ground where people of the same race have found a livelihood in the past.

No wonder that Mr. Petersen has advised the Danish government to send up about a hundred more settlers from the west coast of Greenland to Scoresby Sound. Numbering some two hundred, they may then be left to increase their numbers in peace and bring up children as in the days of old.

The experiment of colonizing Scoresby Sound had its risks, but it has succeeded beyond our fondest hopes. The colony is now firmly established and, if nothing unforeseen happens, will grow to be quite an important one.

Scientific Interests

Furthermore, the new settlement will form a good base for future detailed scientific work on the east coast of Greenland. Dr. Lauge Koch is already in the field and will make a geological survey of the east coast, particularly to the north of Scoresby Sound; and the Danish geodetic survey is planning to erect a seismographic station near the settlement. A wireless will also be built, so that daily meteorological observations can be sent over to Iceland, thereby, meteorologically speaking, to a certain extent safeguarding the Norwegian coast.

Naturally, no scientific work of any extent could have been undertaken by the colonizing expedition[7]; but it may be worth while mentioning that a very good ethnographical collection has been brought home, including a strange burial find—some silver buttons and a handful of silver beads, which certainly cannot be of Eskimo origin. Although it seems far-fetched, the only likely explanation of the origin of the find is that the few silver trinkets must have come from Icelandic hunters who, according to the old sagas, went to Svalbard to hunt in the summertime. The name of Svalbard seems erroneously to have been attached to Spitsbergen, whereas, according to the latest investigations,[8] it seems beyond a doubt that the old-time Svalbard is the Scoresby Sound region of today.

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[7] See papers in *Meddelelser om Grønland*, Vol. 68, 1926, pp. 149–270, received while this paper was in press. Edit. Note.

[8] Gustav Holm: De islandske Kursforskrifters Svalbarde, *Meddelelser om Grønland*, Vol. 59, 1925, pp. 273–297. See also the note "Two Icelandic Cartographers," elsewhere in this number of the *Review*.

NOTES ON THE PROBLEM OF FIELD EROSION

W. C. Lowdermilk and J. Russell Smith

SOME FACTS FROM SHANSI, CHINA[1]

THE Taiyüan plain was suffering from a long drought when the writer's party reached the city of that name at the beginning of July, 1924. The crops were dying for want of rain, even the wild grass had not started and a famine was feared.

The rain clouds broke shortly after our arrival. The moisture accumulated in the atmosphere superheated by the barren, scorching hills came down in torrential volume. The streams were suddenly overcharged with raging waters, heavily laden with mud and silt. Deprived of their soil and forest cover the mountains no longer serve as a storehouse of water. The supply so sorely needed for agricultural purposes quickly ran off the steep slopes, bringing floods and destruction in place of the desired benefits. Efforts made to catch the flood waters for irrigation availed little. Dry weather in the fall months again made conditions serious and renewed the threat of famine.

The writer's party made a study of the destructive processes at work in this general region—the headwaters of the Fen River. The first stage is the cutting of the forest. A portion of the timber cut is transported to market on mule back or otherwise. Transportation is expensive, and only a very small part of the selling price remains to pay the owner. The mountain people consequently are careless with valuable timber. More timber is wasted in the vicinity of Tung Tsa, and more is rotting, than is being grown in the forest plantations on the dry valley slopes about the plain.

The second step is the digging up of the deep fertile forest soil, highly productive and desired for the cultivation of oats and potatoes by the mountain farmer. The region under discussion is mountainous; more than 90 per cent of the area is on slopes with gradients varying from 10 to 80 per cent. Most of the slopes have a gradient of over 20 per cent. This condition explains the operation of the third step—the washing away of the soil.

The rapidity of loss of soil cover varies with the slope; the steeper the slope the more quickly is the soil washed away after it is dug up. In the Tung Tsa region the farmers count on oat crops from cleared mountain land for three to ten years. The amount of harvest decreases rapidly each year until within ten years or less the products become insufficient to pay rent and expenses.

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[1] By W. C. Lowdermilk, University of Nanking, China. For further details see the author's paper "Forest Destruction and Slope Denudation in the Province of Shansi," *China Journ. of Sci. and Arts*, Peking, Vol. 4, 1926, pp. 127–135.

Timber lands are wasted, fertile alluvial ground in the mountain valleys is covered with gravel and stones, and the perennial mountain streams with grassy banks overhung by willows are converted into wide rocky beds—destructive torrents after each rain but dry for most of the year. But, more than this, the soil that is washed off the mountains is being transported to the plains in the flood waters, there to be deposited as the velocity of the flow is diminished. The deposition of this material serves to raise the beds of the rivers above the plain, causes floods, and makes control of the flood waters by dikes expensive and difficult. In order to learn the amount of silt brought down by the torrential run-off, six flood water samples of 1000 cubic centimeters each were taken from three different storms after the crest of the flood had passed. The suspended silt was filtered out, dried at 100° C., and weighed. The amount of silt by weight varied from 14 and 22 per cent. This is a startling amount; it indicates that flood waters are carrying down from the mountains every season thousands of tons of the productive soil layer. And when it is considered that this process has been going on for centuries it is not surprising to find that the mountains of Shansi are rocky and sterile.

That the mountains of Shansi were not always in this barren state is indicated by evidence found in the investigation. Numerous remnants of former forest areas were discovered along the line of travel leading northward out of Taiyüanfu to Jing Loa and thence up the Fen River by Ling Hwa to Tung Tsa. The first was a stand of pines on a northerly mountain slope about 40 li north of Taiyüanfu. A resident of Tsa Shan opposite Ling Jing related that 20 years ago a forest of pine had existed on the mountains and that a fire burning for three days and three nights had destroyed it. A few large pine trees had escaped, remaining as evidence of this cover; and a new growth of pine, visible on the mountain side, had come up after the fire. At Jing Loa a splendid stand of pine surrounds the temple on the mountain side. Ling Hwa is in the midst of a region formerly covered by forests. During that time the city was populous and prosperous. It is said to have been the summer resort of former kings who lived at Taiyüanfu. Its grandeur and prosperity disappeared with the forests. At present a small village stands within the ruins of the former splendid city. Eastward of Tung Tsa in the extensive barren areas are further evidences of a forest cover. Scattered tall spruce trees stand out on the landscape like green pagodas. No seedlings are coming up around them, however, for a spruce seedling requires the shade, protection, and moisture of a fairly well

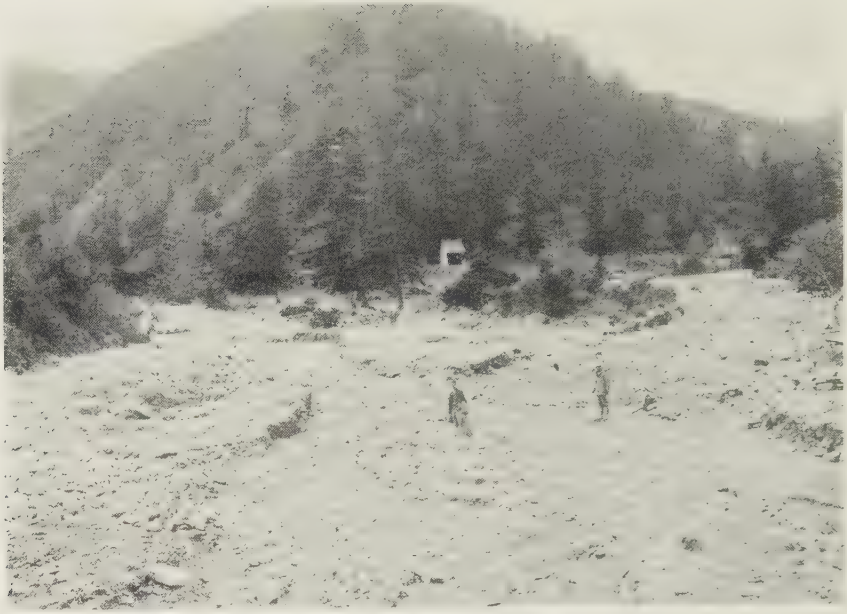

FIG. 1

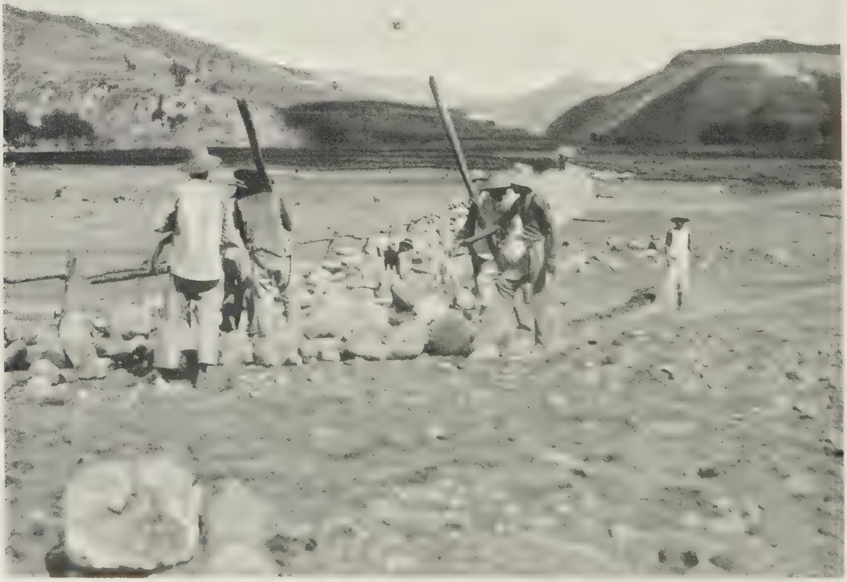

FIG. 2

FIG. 1—The slopes of the two converging valleys have been cleared and cultivated. A perennial stream, resembling a New England trout brook, once flowed through here. It has been converted into this torrential dry rocky bed. (Photograph by W. C. Lowdermilk.)

FIG. 2—View over Tung Tsa and up the Siao Si Ko. Note the wide fan of coarse débris at the mouth of the valley. Its spread is partially controlled, and fields have been protected by the building of walls. (Photograph by W. C. Lowdermilk.)

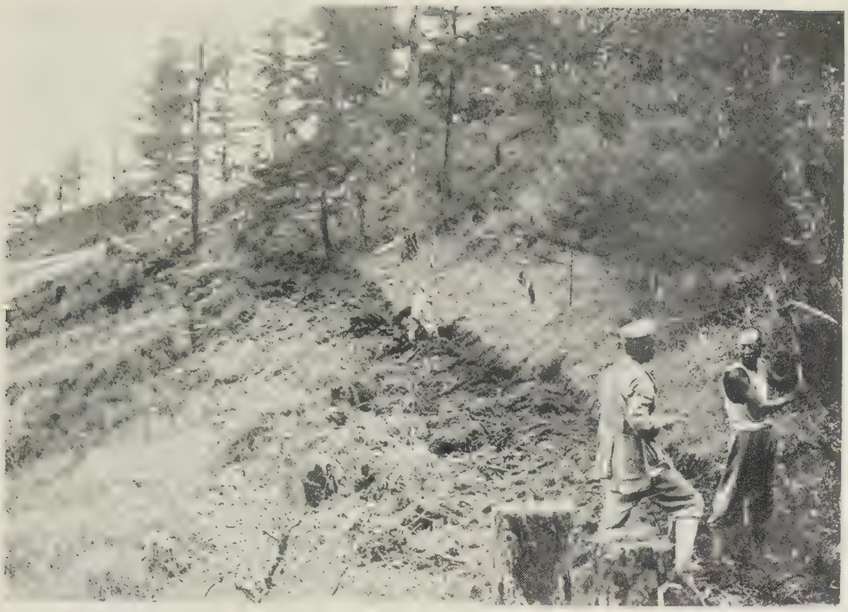

FIG. 3

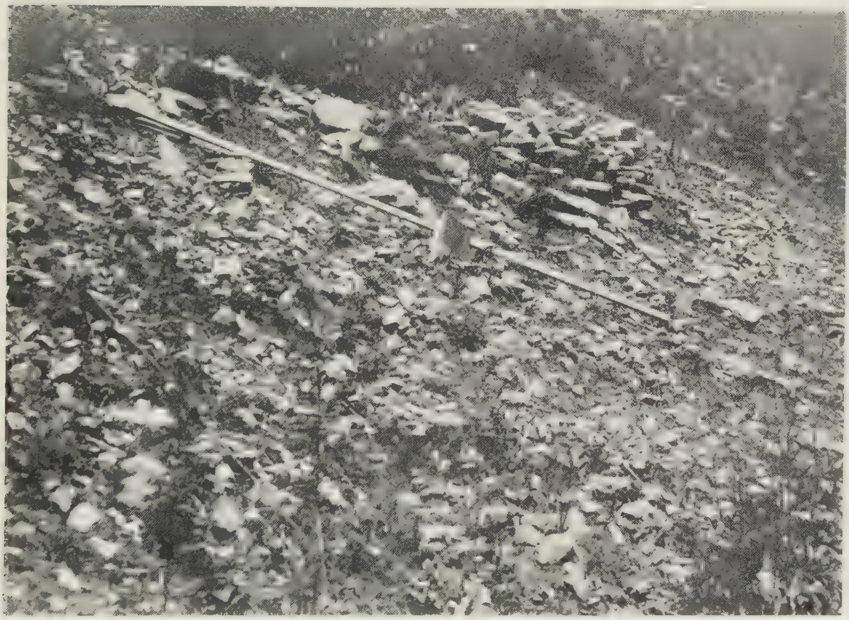

FIG. 4

FIG. 3—The mountain farmer uses a long-bladed pick which effectively loosens the soil from the binding and reinforcing effects of the tree roots. (Photograph by W. C. Lowdermilk.)

FIG. 4—A detail of an abandoned field once covered with forest. This tract had been under cultivation nine years. The black humus layer has disappeared, leaving an unproductive brown rock-filled soil. Near Tung Tsa, Shansi. (Photograph by W. C. Lowdermilk.)

closed forest. West of Tung Tsa, on the other hand, may be seen the processes of forest destruction. Finally, in the vicinity of Yah Shan was happily found the last remnant of the spruce and larch forest cover of that region. It is still in good condition. A certain amount of cutting has been done for years, but the soil has not been dug up and has not washed away, and young trees have replaced those that were cut. Most significant of all, the stream that flowed out of this area by Tien Ping is clear and flows all the year round. The rains that had caused destructive torrents nearer Tung Tsa had scarcely affected the flow in this beautiful mountain stream. One must actually see this tremendous contrast to realize its significance.

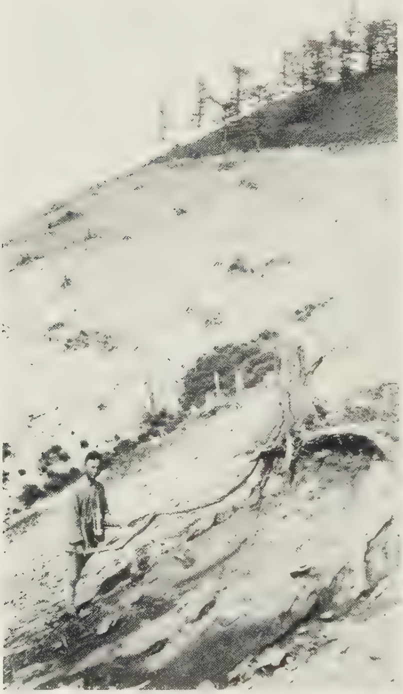

FIG. 5

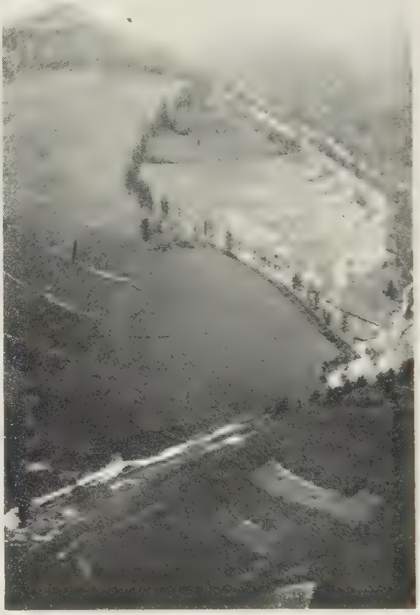

FIG. 6

FIG. 5—Deprived of a protective cover of forest growth the mountain slopes are defenseless before the rapid run-off from the summer showers and downpours. (Photograph by W. C. Lowdermilk.)

FIG. 6—Siao Si Ko, Shansi. Showing the progress of the denudation around the slope, the steeper part being denuded first. The line of trees is part of the original forest cover reserved to mark the property line between two ownerships. (Photograph by W. C. Lowdermilk.)

But this remnant of the former forest cover, which played so important a part a few centuries ago in the defense of China against the attacks of the northern people, is now threatened with destruction. In the summer of 1924 woodcutters were brought in for whole-sale cutting encouraged by the rising prices of timber; and the farmers who annually have to abandon their fields look for more of the fertile mountain forest soil to plant in oats. The second step of soil destruction has also begun. A fate like that which befell the region east of Tung Tsa awaits this productive area, this last heritage of nature to the people of Shansi. It will likewise become useless both for forests and for fields after a few years.

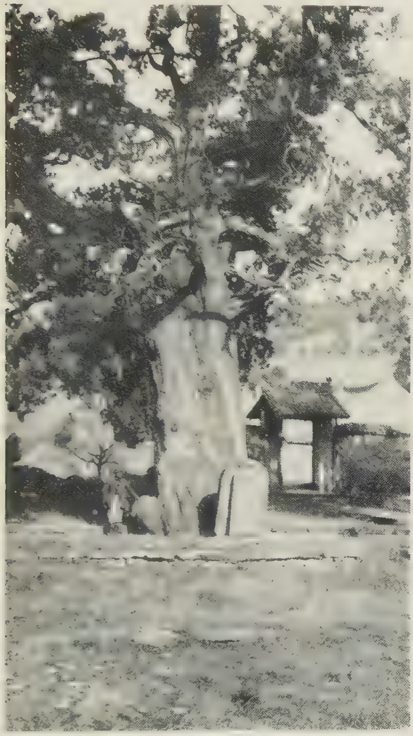

FIG. 7

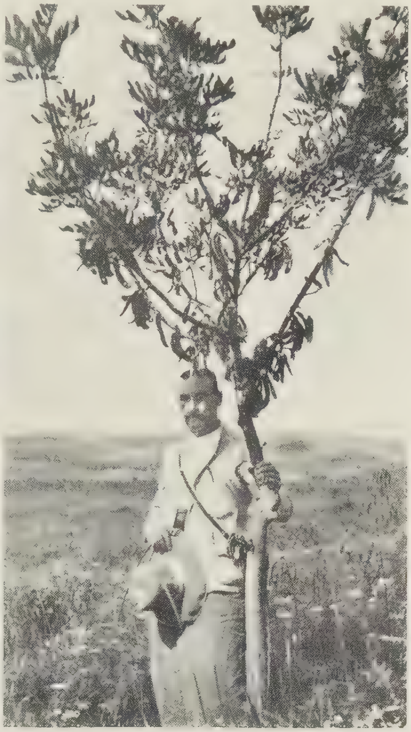

FIG. 8

FIG. 7—This monarch of the temple grounds opposite Jing Loa, Shansi, stands in a region almost treeless, eroded, and desolate. (Photograph by W. C. Lowdermilk.)

FIG. 8—A young carob tree in Northern Algeria showing the crop of beans. Its value is equal to that of Indian corn, and the use is the same. See also Figure 10. (Photograph by J. Russell Smith.)

CHECKING FIELD EROSION: A WORLD PROBLEM[2]

This is a lamentable story as reported by Dr. Lowdermilk, this destruction of an irreplaceable basis of life. It cannot be said that the Chinese do not know better. As one travels across Shansi one sees innumerable terraced fields built in the soft and workable loess. This terracing has been the world's chief defense against the washing

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[2] By J. Russell Smith, Columbia University.

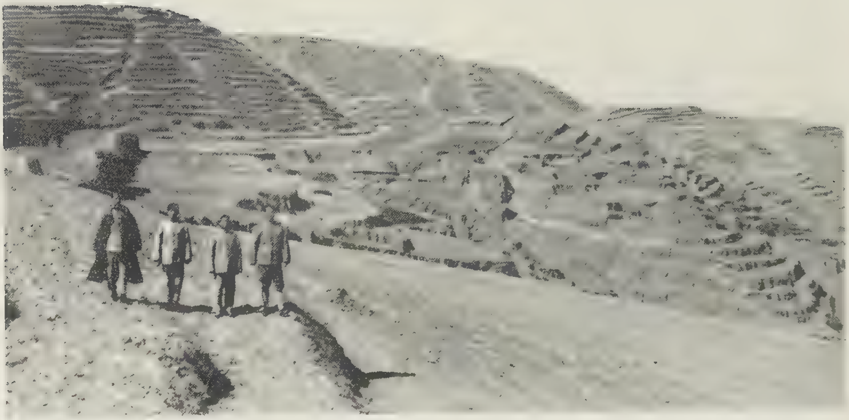

FIG. 9

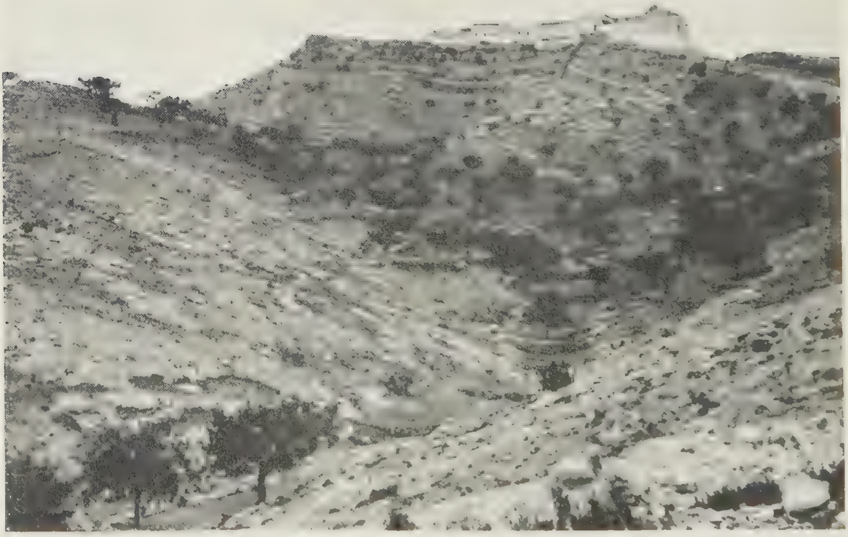

FIG. 10

FIG. 9—Typical landscape in the loess sections of Shansi where the farmers are keeping their soil by terracing. (Photograph by W. C. Lowdermilk.)

FIG. 10—Little patches of earth on this rocky hillside near Valencia, Spain, support an orchard of carobs. This is typical of hillsides throughout the whole length and breadth of the Mediterranean region. (Photograph by J. Russell Smith.)

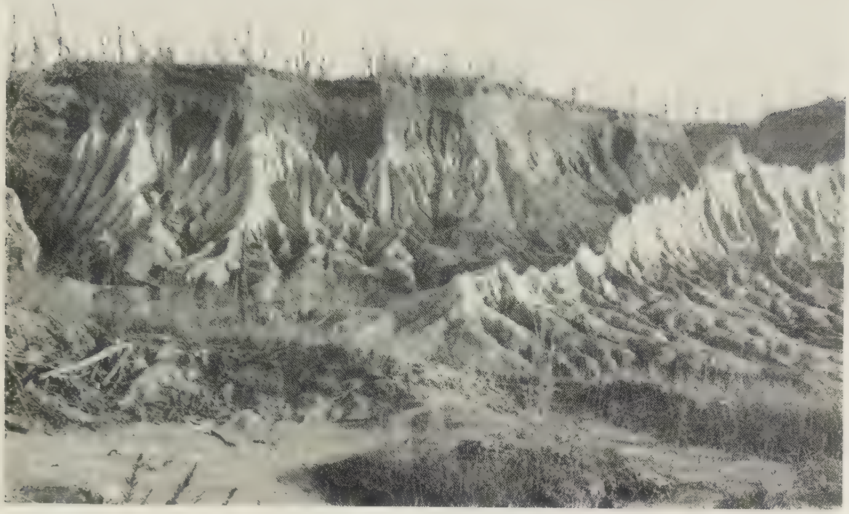

FIG. 11

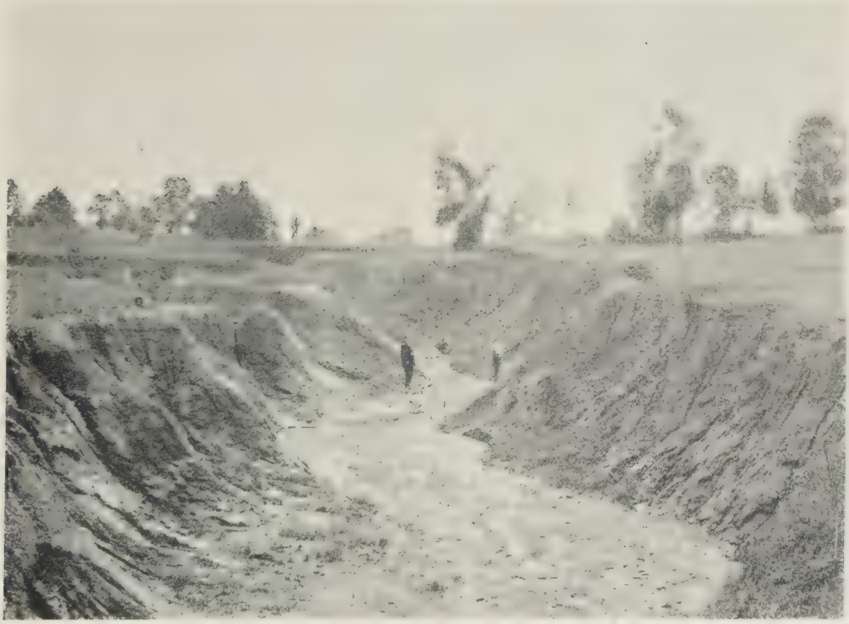

FIG. 12

FIG. 11—This was once a cornfield, Fayette County, Tennessee. (This photograph and Figure 12 by W. W. Ashe, Assistant District Forester, Forest Service, Department of Agriculture.)

FIG. 12—An eroded field in Carroll County, Tennessee.

away of the cultivated hill soil. Unfortunately it is less of a soil saver than one might expect, and on large areas it has not been used at all. Dr. Lowdermilk puts the area of terraced land in Shansi at only ten per cent of the whole. It is probable that in no other place in the world are terraces so easily made or so badly needed as in this loess. But let us not be too hard on the Chinese. The most appalling part of the situation is that they are so much like the rest of us.

I have made some investigation of the duration of corn culture on hill lands of the southern Appalachians. I find a striking similarity in the number of possible harvests of corn, the chief crop, there, and of oats, the chief crop, in Shansi: both in Shansi and in America ten or a dozen crops, and then the land is ruined. It is true the destruction is not quite so complete in southern Appalachia as in Shansi, for there is usually some forest growth after the end of the corn-and-gully cycle. Americans, luckily, have not resorted to that twin curse of Asia—sheep and goats. The second-growth forest is, however, much poorer than the original, and much of the land is never thought of again as agricultural land.

The works of McGee, Ashe, Bennett, and others of the U. S. Department of Agriculture show clearly that soil loss in the United States, through needless erosion, is a waste that in two or three millenniums or less, at present rate, will destroy the home space of scores of millions of men. Yet we do almost nothing about it. The writer has repeatedly called attention to the Old World solution of this problem by a tree-crop agriculture.[3] A partial survey of the Mediterranean area shows hill lands planted to a variety of crop-yielding trees—a custom that almost merits the name of permanent agriculture. It is not new. Many of these Mediterranean slopes, clad with chestnut trees, acorn-yielding oak trees, olive trees, pistachio (nut) trees, carobs, and other crop-yielding trees, have been in continuous production since long before Columbus discovered America. Meanwhile we destroy county after county with from 10 to 20 crops of corn, cotton, tobacco, and gullies, though there is little doubt that crop trees, producing either human food or forage as profitable as corn, offer one of the best possible means of saving the soil of hill lands for our grandchildren. Several years, probably decades, of scientific work are needed to put these crops on American hills. Immediate returns cannot be expected.

I do not wish to give the impression that the mere perfection of a series of crop trees is the whole of this work. A crop is not an agriculture or a farm or a community. We need a whole new type of agriculture—one that can live on hills and let the hills live. This requires the working out of new types of *farms*, that is, harmonized crop series; and it calls for studies in agricultural economics and farm economics. New types of rural organization also will be needed. All this work—regional planning, community planning, farm planning, and the creation of new crops, *really new crops*—is work that does not pay dividends to investors. Therefore our individualistic, profit-seeking civilization has not developed the organs to do it. American legislatures, state and national, are all alike bound by the political necessities of voting for measures of more immediate concern.

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[3] See, for instance, "The Oak Tree and Man's Environment," *Geogr. Rev.*, Vol. 1, 1916, pp. 3–19, and "Farming Appalachia," *Rev. of Revs.*, Vol. 53, 1916, pp. 329–336.

Can it be that no one will undertake this farseeing work? Can it be that the Chinese in the basin of the Hwang Ho and the Americans of the Ohio valley, of Appalachia, and of our other hill lands are going to keep on sending their farms down to the sea?

SOUTH DAKOTA AND SOME MISAPPREHENSIONS

Freeman Ward

Lafayette College

THE geographies of our grandparents included the area now occupied by South Dakota as part of the region described as the "Great American Desert." And it was not so.

When the writer was a boy living in South Dakota even some of the relatives in the east thought we lived in sod houses, burned hay to keep warm, were constantly menaced by savage Indians, and had three blizzards a week. And it was not so.

A few years ago a popular author wrote a long article for one of the leading periodicals making much over the financial no-accountness of South Dakota. And it was not so.

It is true that part of South Dakota is semiarid, but there is no desert. There are sod houses occupied by people in South Dakota, but there are also many more steam-heated houses with hardwood floors and bathrooms. There have been many bank failures in South Dakota, but there have been more of them in other prairie states; and 4.6 per cent of the agricultural wealth of the nation is in this state. Environment with its natural resources is one thing, time is another. South Dakota as a state is only thirty-seven years old.

It is here proposed briefly to indicate the varied character and resources of the state and thereby correct these all-too-common misapprehensions.[1]

DIVERSIFIED SCENERY

Many people think of the scenery of South Dakota as flat and monotonous. The word "Dakota" suggests prairies or plains: perhaps, too, the observer has got his impression of the state simply by passing through on the Chicago, Milwaukee, & St. Paul Railway. There are indeed stretches miles long where the land is so flat that one could almost play billiards on it; but on the other hand, there are places so rough that an experienced mountain climber would encounter difficulties. Between these extremes there are many degrees of relief. In fact, South Dakota's honors in the matter lie largely in the fact that there is such a variety of scenic types. In addition there is at least one unique sort—the Badlands—unique and striking enough to be set apart as a National Park.

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[1] For a systematic geographical description of the state see S. S. Visher: The Geography of South Dakota, *S. Dak. State Geol. and Nat. Hist. Survey Bull. 8*, 1918.

South Dakota falls within two major physiographic provinces, the Prairie Plains and the Great Plains. Within the latter is that mountainous uplift called the Black Hills (see Fig. 1). The valleys of the half dozen main streams may be considered smaller subdivisions in each province. The Badlands and coteaus could also be considered separate types. The Missouri River divides the state roughly into eastern and western halves. It is a common expression to say "west of the river," meaning in the western half of the state.

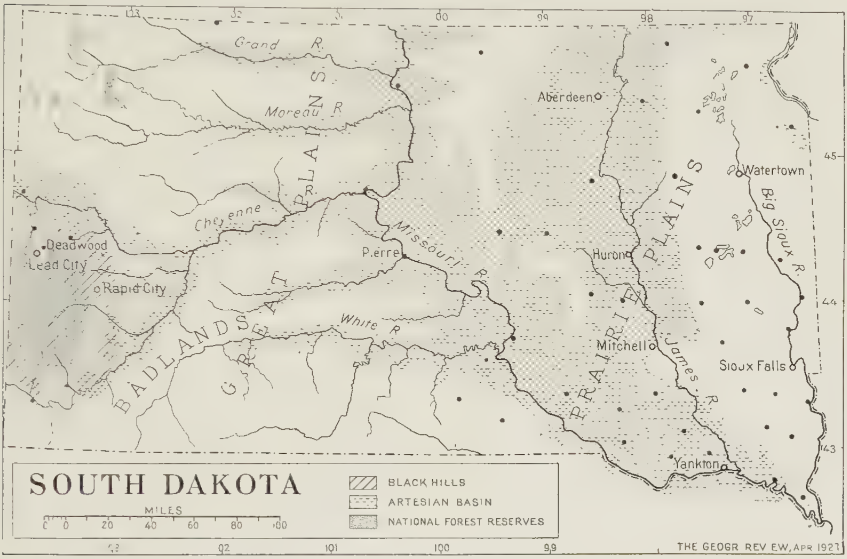


FIG. 1—Sketch map of South Dakota showing the chief physiographic divisions of the state and also the Artesian Basin and National Forest Reserves. Larger population centers are shown by an open circle; smaller centers (over 1000) by dots. Scale of map approximately 1:6,000,000.

PRAIRIE PLAINS

East of the river the topography is well generalized by the term "prairies." Probably the flattest part of the state is in the central portion of this eastern section. On the other hand there is a great deal of gently rolling country, and in certain restricted zones there are morainal ridges with their "knob and kettle" irregularities rising as a whole above the general level of the region. Locally there are sharp downward departures from the flowing prairie profiles. In Minnehaha County are the "Dells" and "Palisades," etc., small canyons with precipitous sides, 40–80 feet high, cut in red quartzite—delightful beauty spots, especially where the setting is well wooded.

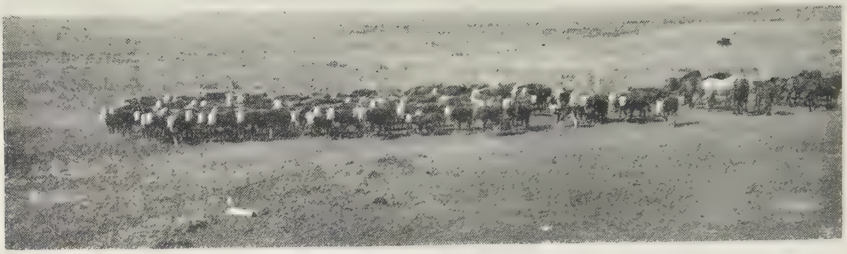


FIG. 2

FIG. 3

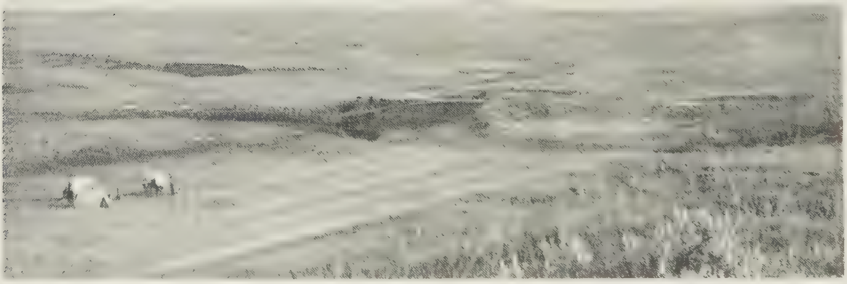


FIG. 4

FIG. 2—Prairies of eastern South Dakota.
FIG. 3—Prairies in western South Dakota.
FIG. 4—Plains topography in western South Dakota. Rabbit Butte in the distance.

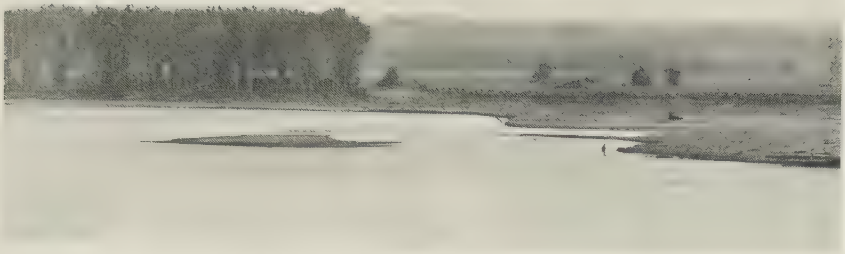
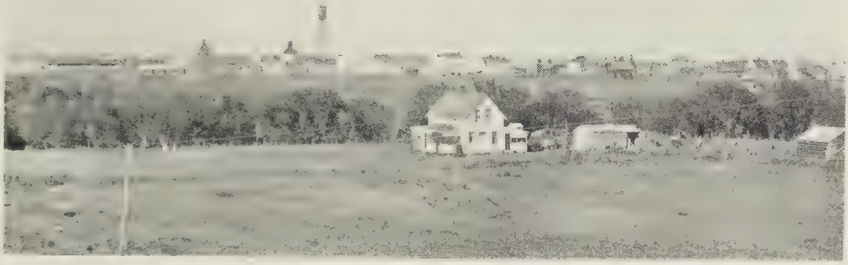


FIG. 5



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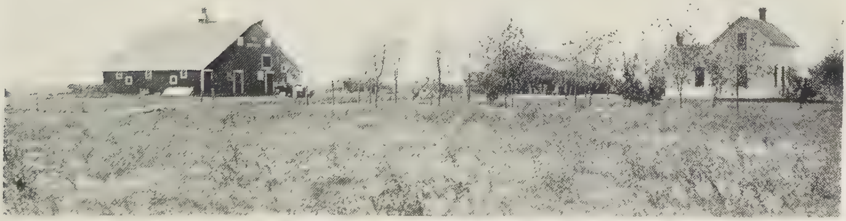

FIG. 7

FIG. 5—In the Missouri River valley. A typical landscape of the open valleys.
FIG. 6—Typical small town of South Dakota with wooded creek in foreground.
FIG. 7—A typical group of farm buildings. "Tree claim" started.

Two prominent upward departures from the general prairie undulations are the Bijou Hills and the Wessington Hills.

Two southward-flowing streams, the James ("Jim") and Big Sioux Rivers, carry most of the run-off. This eastern part of the state is, however, poorly drained. Such drainage as there is can be best described by calling it unorganized; some parts are hardly drained at all, and lakes are abundant. This is quite in contrast with the well organized drainage system of the western half. The eastern part has been glaciated, while the west has not.

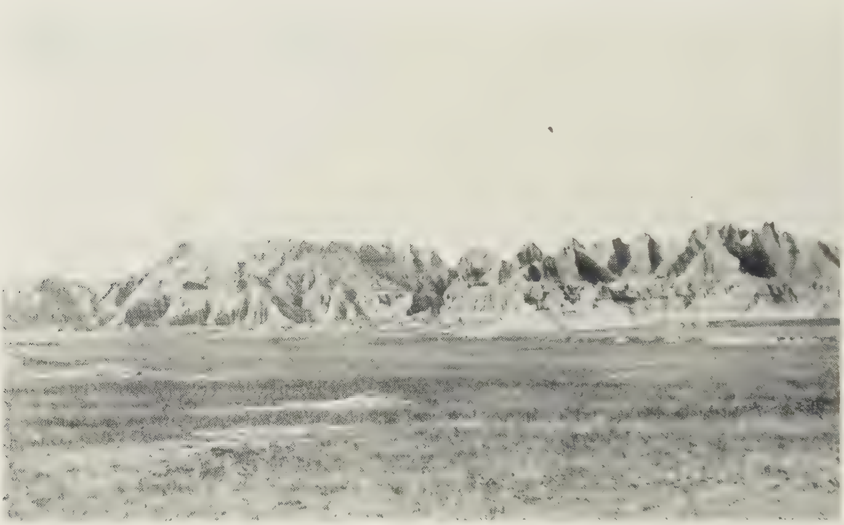
Fig. 8—A portion of the Badlands "wall."

Great Plains

In the western part of the state there is a greater variety of topography. There are flatter plains-like portions, and there is the gentle to steep rolling surface. A rather common feature is that remnant of erosion, the butte. If one should look at, say, Thunder Butte or Rabbit Butte, from a distance of five or ten miles one would see well displayed the plains topography so typical of much of western South Dakota. Erosion remnants larger than buttes and with extensive summit areas are the Cave Hills and Slim Buttes in the northwestern portion. Their steep sides notched by ravines and canyons give them a striking prominence and attractiveness.

A unique topographic feature is the Badlands. While there are smaller patches of badlands in many places, the Big Badlands are in the White River country in the southern portion of western South Dakota. This is the area originally so named and the type area for that sort of topography. The badlands proper (for there are both good ranch lands and badlands proper in the Badlands area) are erosional forms of great variety and picturesqueness. Castellated pinnacles, mazes of small and large canyons and draws, bare slopes, bright colors, jagged outlines, and imitative forms impressively combine in seeming confusion; but they have a system of their own and aré an unending delight, solace, and inspiration to any one who takes time to know them. Much of this topography is very rough, only in a few places can a wheeled vehicle pass through; indeed a saddle horse has difficulty in getting about over much of the Badlands, and there are portions where the climber on foot cannot gain passageway.

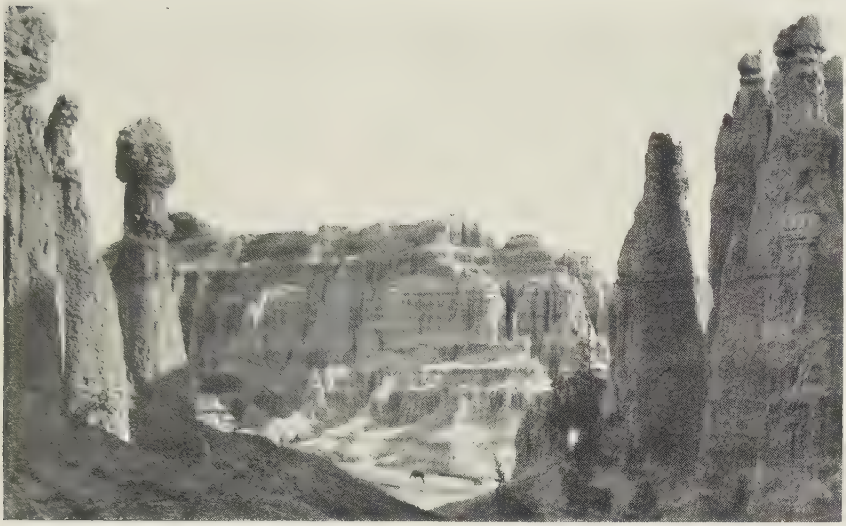
FIG. 9—A picturesque canyon in the Badlands.

BLACK HILLS

Unlike most of the prairie states South Dakota has real mountains. In the westernmost part of the state is the mountainous mass known as the Black Hills. From prominent elevations on a clear day these mountains can be dimly seen in outline as far off as a hundred miles. Twenty-five miles away they rise up dark and massive several thousands of feet above the general level of the plains. The nearer one gets the more impressive they become. But it is not until one is within the Hills themselves that the beauty and charm of the high peaks, deep valleys, wooded slopes, and sparkling streams really descend upon one. The Rockies are more massive but do not excel the Black Hills in beauty. Within a small compass all types of mountain scenery are included—rugged peaks, high meadows, hogback ridges, wooded valleys, sharp canyons—all the forms dear to the heart of the mountain lover. An additional attraction is Wind Cave National Park.

The Black Hills are well drained by many streams that run radially from the highest central portion. They empty into the Cheyenne directly or indirectly via the Belle Fourche River. The Cheyenne is one of five rivers that have a general easterly trend across the western part of the state to the Missouri. All of these have abundant tributaries, though most of the tributary valleys carry streams only during the rainy spells of the year.

Valleys

Of the many open valleys besides that of the big Missouri River mention may be made of the Grand, Moreau, Cheyenne, Bad, and White Rivers. They are incised 100–300 feet below the general prairie level, have broad flood plains, and are bordered by steep bluffs or by sharp "breaks," the result of the development of short deep tributaries. In most cases, between the "breaks" and the farthest valley edge is a flat, high terrace or bench from a quarter of a mile to two or more miles wide in the main valleys and sometimes continuous for as much as five or ten miles with only an occasional tributary ravine trenching across on its way to the main. For the most part they are fragmented freely by the tributaries. These benches furnish excellent settlement sites, accessible to the stream without danger of flooding, a feature taken advantage of by the early inhabitants of the region. In the dim past the ancient Arikara civilization commonly used these benches as village sites.

The meandering stream channel, the occasional interrupting islands, the thick growth of willows, cottonwoods, and ash complete a picture of which one never tires.

The physiographer will find interesting study in the drainage patterns of this region. While the five main rivers flow nearly east to the Missouri and the tributaries in general have a dendritic pattern, yet the proportion of tributary fragments having a northwest-southeast trend is astonishing. Even many of the south-side tributaries of the eastward flowing mains have a northwest trend. The Pierre topographic sheet shows this in detail. Since the very uniform Pierre Shale covers so much of western South Dakota and there has thus been no directing of erosion by harder members, this northwest-southeast trend must be an inheritance from an earlier cycle of erosion. Nebraska, particularly in the tributaries of the North Platte, continues this pattern. The dominant pre-glacial drainage must have been southeast before it later developed its eastward trend, probably in response to warping.

A composite profile of the Missouri River valley and adjacent territory is shown diagrammatically in Figure 10. This indicates three cycles of erosion. They have been provisionally named the Prairie Cycle (P), Bench Cycle (B), and Valley Cycle (V). The profiles of all the mains, and most of their tributaries, draining into the Missouri are of a similar character. In some cases the benches are double. In some places the bench is fragmentary, being marked by a series of smaller butte or mesa crests. The Valley Cycle is a composite of cut, fill, and terrace. Profiles in the Black Hills show related forms. All of these cycles are post-Oligocene in age. No doubt they will sometime be tied up with the cycles in the Rocky Mountains.[2]

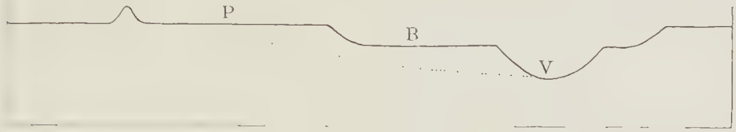

FIG. 10—A diagrammatic profile across the Missouri River valley. P, general prairie level above which buttes rise and below which tributaries are cut; B, high bench; V, river valley with its terraces and fill.

A word or two about the actual elevation of the state should not be amiss. Outside of the Black Hills the state may be thought of, in the large, as a surface sloping from an average of about 3000 feet on the west to about 1200 on the east. The departures (Slim Buttes, Black Hills, river valleys, etc.) from this have already been mentioned. The highest point is Harney Peak, in the Black Hills, 7242 feet above sea level. This is the highest peak in eastern North America. The lowest point in the state is Big Stone Lake—965 feet. Five-sixths of the area is below 3000 feet, one half the area is 2000 feet or less above sea level. For local relief the Black Hills lead with a relief of 4000 feet, the Badlands are next with 500 feet.

SOUTH DAKOTA WOODLANDS

Another erroneous impression besides the mistaken conception of unending flatness is that South Dakota is treeless.[3] It is true that much of the western part of the state is semiarid and so characterized by steppe[4] conditions with its predominant grasses and other associated small plants. Yet while it may be admitted that there are many wide stretches without a tree, to characterize the whole state as treeless is not only inaccurate but quite derogatory. A large section of the Black Hills and portions of the Slim Buttes and Cave Hills have a sufficient stand of timber to be set off as National Forest Reserves (see Fig. 1). In addition, the valleys of all the main streams and many of the creeks have timber. Indeed, one of the reasons for the attractiveness of the valley scenery is not only the rougher topography, but also the wooded character in sharp contrast to the flatter, treeless prairies adjacent. In the eastern half of the state, where settlement is older, there are many groves set out as "tree claims" by the early settlers. It is substantially true that the size of the trees in South Dakota towns is directly proportional to the age of the towns themselves.

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[2] W. T. Lee: Peneplains of the Front Range and Rocky Mountain National Park, Colorado, *U. S. Geol. Survey Bull. 730 A*, 1922.

[3] Compare also Mr. Charles A. Gillett's protest against common misconceptions regarding North Dakota in his paper, "Forests and Forestry in North Dakota," noted in the Record section of this *Review*.

[4] S. S. Visher: The Biogeography of the Northern Great Plains, *Geogr. Rev.*, Vol. 2, 1916, pp. 89–115.

It must not be lost sight of, too, that there is an abundance of bird and flower life, not only in the wooded areas but also in the grassy prairies as well.

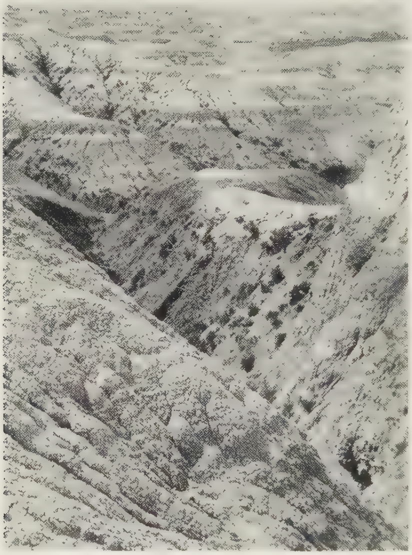

Fig. 11—Vista from Big Foot Pass, Badlands.

Mistaken Ideas of Climate

Contrary to much popular belief, South Dakota is not the home of the blizzard. If we accept the technical description of a blizzard as a heavy snowstorm with high wind and cold wave, we have fewer blizzards than the eastern United States, for our winter precipitation is much less. If we accept the storybook and newspaper accounts of this phenomenon, we have one about every twenty-five years.

South Dakota's position in the middle of the continent assures a typical continental climate. No South Dakotan claims for it a temperature regimen like Florida or Southern California; but its climate assuredly is invigorating and healthful, as shown by the health statistics of its inhabitants.

As far as temperature is concerned, South Dakota has cold winters and warm summers. Continental climates characteristically run to extremes. Alas for the lack of discrimination of mankind! Extremes always make the best stories and the most lasting impression. Statements concerning the extreme cold similar to those about our rare blizzards have given a vivid impression of arctic winters in South

Dakota. Some facetious anæmic is responsible for the characterization of the climate as "nine months winter and a darn cold summer." As far as extremes go it must not be forgotten that while sub-zero weather is a fact, so also is it a fact that we have occasionally had lawn parties in November, tennis at Christmas, and plowing in February.

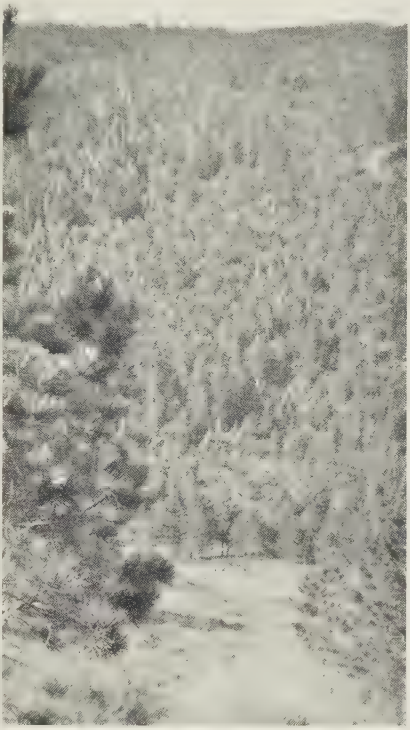

FIG. 12—View in the Black Hills Forest Reserve.

The reader should not stand aghast to learn that the temperature in South Dakota has reached a minimum of 50° F. below zero. This is a record that was made on one day of a particularly cold winter and in only one part of the state. Our coldest months are December, January, and February; and the mean temperatures for those months at Huron (the average latitude of the state) are 15.7°, 9.5° and 12.9° respectively: this, too, during a record of 23 years.

Perhaps a truer conception of the winters may be had by considering some official Weather Bureau records of one town in the southeastern part of the state. The period covered is the last 21 years. There has never been a winter without a temperature below zero. These cold spells come chiefly in December, January, and February: November and March sometimes have temperatures as low as this. In nine Marches and five Novembers out of the 21 there have been a few days of below-zero weather. The lowest temperature reached for this particular town was 38° below zero, which occurred just once in the 21 years. Nor is a temperature lower than 20° below zero common; indeed, not once in ten of the years did this degree of cold occur. Furthermore, the sub-zero weather holds usually for only three to five days at a time. In this town light furnace fires have had to be maintained in some years as early as the first week in October and in other years not until the first week in November. The snowfall is not usually heavy, although because of the wind, good-sized drifts form.

This picture of moderate cold most of the time with occasional short periods of sub-zero weather is true of the winter throughout the state. One should not lose sight of the fact that there are also short periods of warm, above-freezing weather from time to time.

Similarly for the summers. Extremes above 100° are common, but there are no long periods of such extremes. The daytime maximum more commonly by far ranges from 85° to 95°. A compensating feature is the great prevalence of cool nights.

In considering the effect of climate on man, statistics are one thing and comfort is another. In other words, the sensible temperatures are the ones to be considered. In this regard the dryness of the atmosphere in South Dakota ameliorates the extremes as recorded by the thermometer. For instance, zero weather along the Atlantic coast is more uncomfortable than 15 degrees below in South Dakota. Similarly a summer day in the national capital with the thermometer at 100° has a prostrating effect, while the same temperature in South Dakota does not so woefully affect the bodily feelings.

The eastern half of the state is humid with an average annual precipitation of about 23 inches. The western half, except the Black Hills, should be rated as semiarid with an annual precipitation of about 17 inches. An advantageous fact about the rainfall is that over 80 per cent of it falls between March 1 and September 1; that is, during the growing season when the crops are in especial need of it.

A natural result of the amount and type of precipitation is the large number of sunny days. The percentage of sunshine is not as great as in the arid southwestern United States but is high enough to justify to some extent the use of the term "Sunshine State" for South Dakota. The air of South Dakota is invigorating, bracing, and stimulating.

Varied Natural Resources

One popular conception of South Dakota—that of its agricultural strength—is correct. This state has for years been among the leaders in wheat and corn production. Other crops such as oats, barley, rye, flax, and hay are raised in large quantities each year. The state is one of the leaders in poultry production. It is to be expected also that there is a large production of beef cattle and horses. What is less known is that dairying is an important industry and the wool clip amounts to over four million pounds annually.

In regard to agriculture, the eastern and western sections differ in their dominance. Wheat, corn, and small grains are best raised in the eastern half. No one should expect to make a continuous success of these in the semiarid west, but that land flourishes in its appropriate way. One of the most successful combinations is dairying and alfalfa, with hogs in numbers proportional to the milch cows. Cattle and sheep raising offer suitable opportunities but require a larger acreage.

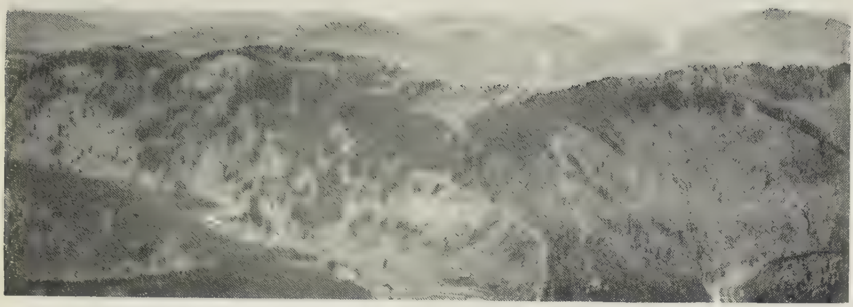

FIG. 13

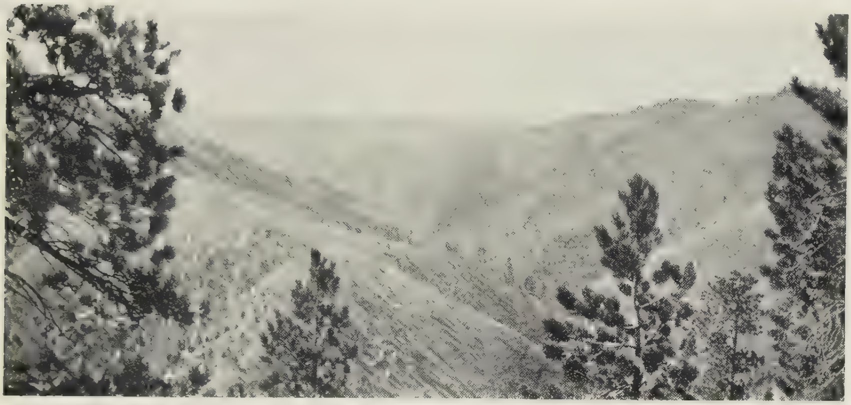

FIG. 14

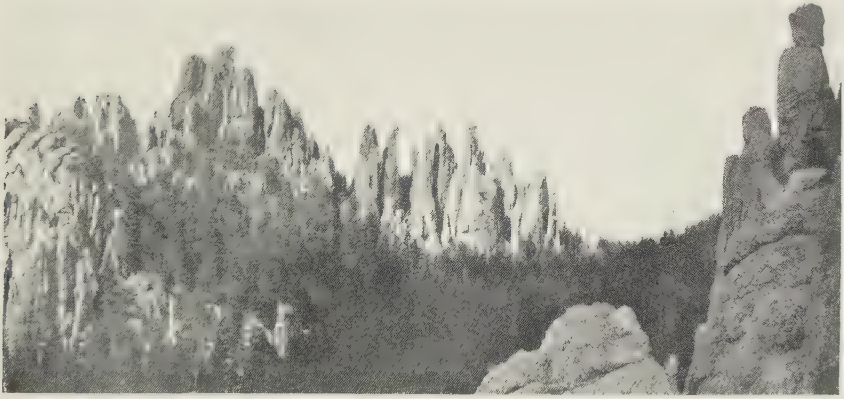

FIG. 15

FIG. 13—In the Black Hills. The smoke in the distance is from Lead City (Homestake Mine).

FIG. 14—Wooded slopes of the Black Hills.

FIG. 15—Granite needles near Harney Peak. (From Pl. 62 of N. H. Darton's "Preliminary Description of the Geology and Water Resources of the Southern Half of the Black Hills and Adjoining Regions in South Dakota and Wyoming," *U. S. Geol. Survey 21st Ann. Rept. 1899–1900, Part IV—Hydrography.)*

The forests of South Dakota occupy over a million acres, chiefly in the Black Hills. Several sawmills thrive there, and an annual cut of 20 million board feet or more is usual.

The mineral resources of the state are not so well known. There are probably fifty different varieties of rocks, of which some 15 have been used commercially. There are over 180 mineral species in the state, of which about 40 would be listed as "useful" from a commercial standpoint. South Dakota has the largest gold mine, the Homestake, in North America, which yields between six and seven million dollars' worth of that metal annually. The state has been among the larger producers of mica, bentonite, lithia, and gypsum. She has been a steady though small producer of silver, lead, and arsenic, and includes tungsten and tin among other mineral resources occasionally produced. All of these are derived from the Black Hills. Large cement resources are also found in this district as well as in the eastern part of the state.

Outside of the Black Hills crushed stone, sand and gravel, chalk, artesian water, and gas occur in commercial quantities, and the production of some of these reaches into considerable figures. In the northwestern part of the state coal, lignitic to sub-bituminous in quality, occurs in quantity.

The undeveloped resources include many minerals in the Black Hills, clays through the state, coal, water power, and oil. In regard to oil, it is believed that the state is entering upon a bright future. Showings of oil have been encountered, "domes" located, and drilling started. It is believed that in the near future commercial oil will be found somewhere in the western part of the state.

Opportunity in South Dakota

To appreciate the opportunities offered by South Dakota one must first realize its size. From north to south the distance across the state, 200 miles, is that from New York to Washington; from east to west, 370 miles, is as far as from Boston to Buffalo. All of New England plus Delaware and New Jersey could find room in its 77,615 square miles. It is verily a region of distances, vistas, and broad outlook.

With all its great size, South Dakota has a total population less than the city of Boston. This, however, is not to be taken as a suggestion of backwardness, but rather is a measure of her newness. South Dakota is a young state, and it takes time to grow up. Dakota Territory was incorporated in 1861, and South Dakota became a state as recently as 1889. In 1870 the total population of the territory now occupied by South Dakota was less than 12,000; in 1890 this had increased to over 328,000, and the population now is 681,560.

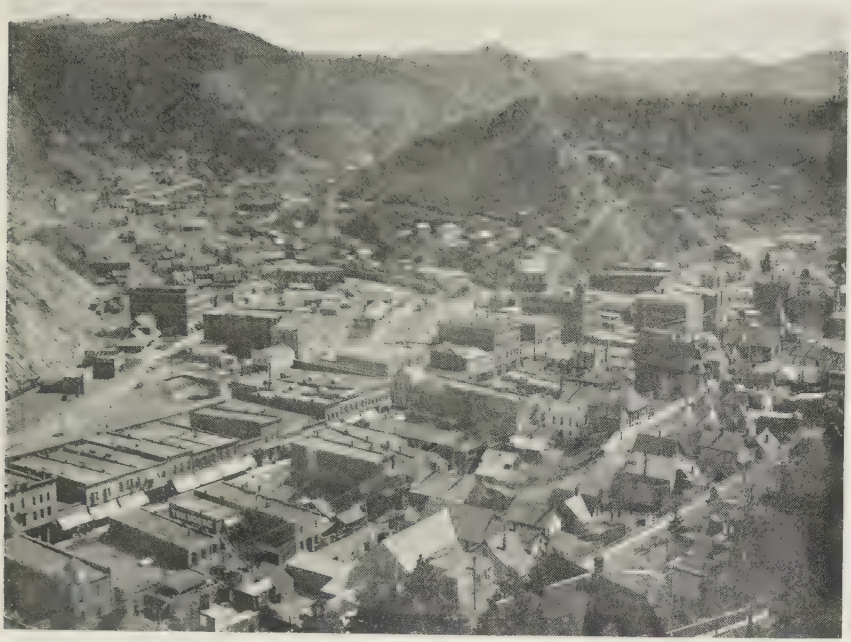

FIG. 16

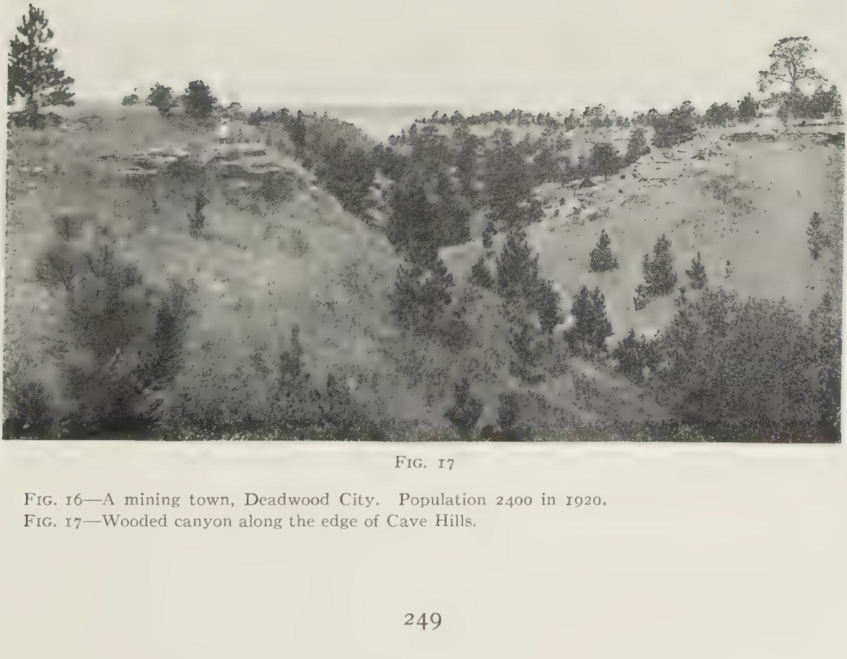

FIG. 17

FIG. 16—A mining town, Deadwood City. Population 2400 in 1920.
FIG. 17—Wooded canyon along the edge of Cave Hills.

In 1880 there were only four towns that had more than 1000 population, and none of these had as much as 4000. In 1900 there were nearly three times as many towns and cities; 25 of them had over 1000 inhabitants, and one had over 10,000. In the year 1925 there were 5 cities whose population was over 10,000, the largest having 30,127; there are now 56 towns each with a population of 1000 or more.

Another indication of growth is the railroad mileage: in 1870 there were no railroads at all; in 1890, 2485 miles, and now 5068 miles. Scores of people now living have seen the change from a state with no schools at all to a state with a University, a School of Mines, an Agricultural College, several colleges under denominational control, normal schools, and a well established public school system. There has been a corresponding development of agriculture, industries, public utilities, etc.

The size of the state means that there is lots of room. The figures given above show that there has been a steady and rapid growth, all of which spells opportunity.

PERSISTENCE OF FEATURES IN AN ARID LANDSCAPE:

THE NAVAJO TWINS, UTAH*

Kirk Bryan and E. C. La Rue

U. S. Geological Survey

IN arid regions where sparse vegetation leaves bare every lineament of the scarred face of nature questions of the origin and persistence of the landscape force themselves on our attention. Intricate but boldly carved canyons, cliff and precipice ornamented with pillars and pinnacles delicately poised, waterless stream channels strewn with the litter of floods—all these testify to erosive processes obviously now in action and apparently of almost catastrophic violence. "Ancient as the hills" seems an ironic phrase. It is easy to lose perspective and to conceive of the rate of erosion as much more rapid than it is in fact. Opportunities to gain a conception of the rate of erosion are rare, and actual measurement scarcely practicable with present methods and facilities. The best estimates of erosion are indirect: instead of measuring loss of volume of the hills we measure the material carried by streams in solution and in suspension at some point near their mouths. By this method it is estimated that the surface of the United States is being removed at the rate of one inch in 760 years, whereas in the Mississippi River drainage basin the wastage is one inch in 500 years, and in the Colorado River drainage basin the rate is slightly more rapid, or one inch in 440 years. The mud and the invisible salts have been derived from the whole watershed, and we have no way of knowing how much came from this or that place. Any opportunity of making a direct estimate of comparative rates of erosion, quantitative or qualitative, is therefore most welcome. Such an opportunity occurred to the writers in southeastern Utah. The observation had been planned for some years by Mr. Bryan, and the chance of carrying it out came to Mr. La Rue in 1925 during the course of an engineering investigation.

THE NAVAJO TWINS

North of Bluff, a frontier outpost on San Juan River, rises a crenulated sandstone cliff which forms the northern boundary of the open valley of that river. On a slight promontory of this cliff stand the conspicuous rock pillars known as the Navajo Twins. These differ from others on the cliff only in being more slender, fragile, and prominent. They are formed from a sandstone (Upper Jurassic) with well developed vertical joints which overlies red shale with limy and sandy bands.

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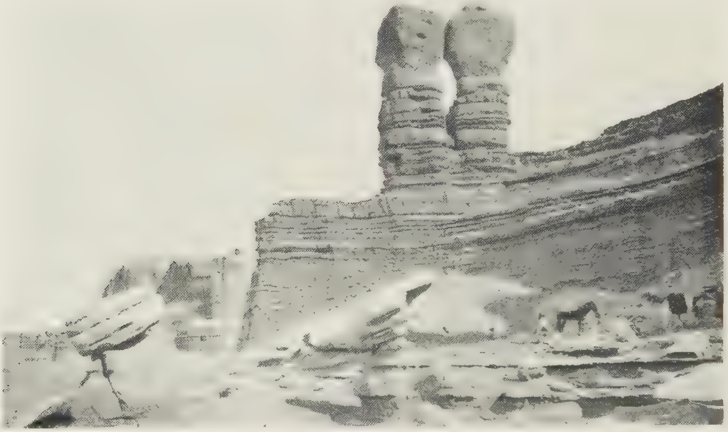

Fig. 1

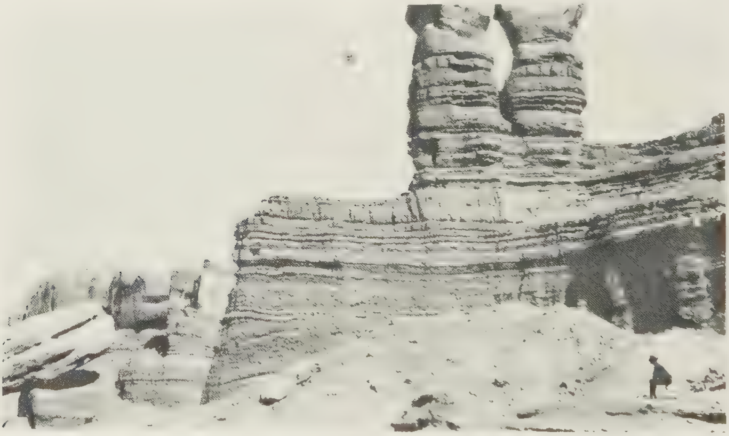

Fig. 2

Fig. 1—The Navajo Twins as photographed by W. H. Jackson in 1875.
Fig. 2—The Navajo Twins as photographed by E. C. La Rue in August, 1925, from the same point as that used by Jackson in 1875.

The fall of the Navajo Twins seems imminent. But fifty years ago it also seemed imminent, as shown in the photograph, Figure 1, taken by W. H. Jackson of the Hayden Survey, during his exploration of this region in 1875. Setting his camera as nearly as possible on the spot from which Jackson took his picture, La Rue, in August, 1925, took the photograph reproduced in Figure 2. The Twins are seen from the same angle and have not changed in any visible way in the fifty-year interval. Another pair of photographs, Figures 3 and 4, taken in 1909 (by E. G. Woodruff) and 1925 (by La Rue) respectively again indicates no essential changes in the Twins.

In the foreground of Jackson's photograph of 1875, Figure 1, are two pedestal rocks of sandstone, evidently fallen from the cliff above, resting on pedestals of shale. In the Woodruff photograph and in both of the 1925 photographs the nearer of these rocks is in place, and no essential changes have taken place; though a slight accentuation of the carving of the base appears in Figure 4, which may be due to differences in different times of the day and the year. The pedestal rock at the rear had disappeared as early as 1909 at least. Was this due to erosion in the interval? By the operation of natural forces, principally differential rainwash,[1] the block might fall from the pedestal, but it should not wholly disappear while others of the same size, still visible, have not yet crumbled away. According to local testimony

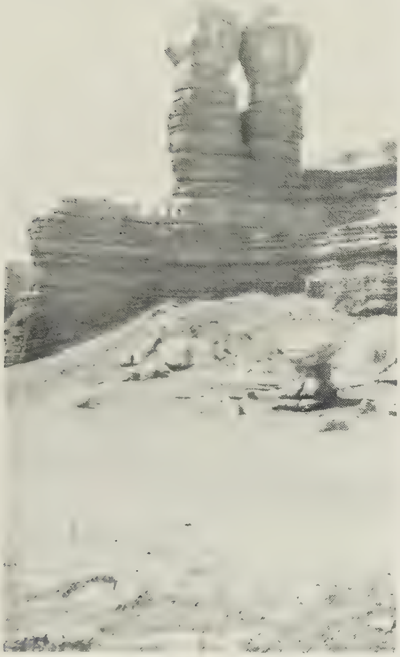

FIG. 3

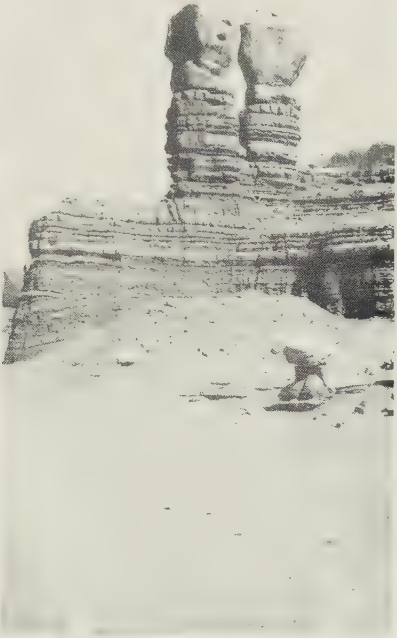

FIG. 4

FIG. 3—The Navajo Twins as photographed by E. G. Woodruff in 1909.

FIG. 4—The Navajo Twins as photographed by E. C. La Rue in 1925 from the same point as that used by Woodruff in 1909.

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[1] Kirk Bryan: Pedestal Rocks in the Arid Southwest, *U. S. Geol. Survey Bull. 760-A*, 1923; *idem:* Pedestal Rocks Due to Differential Erosion, *ibid., 790-A* (in press).

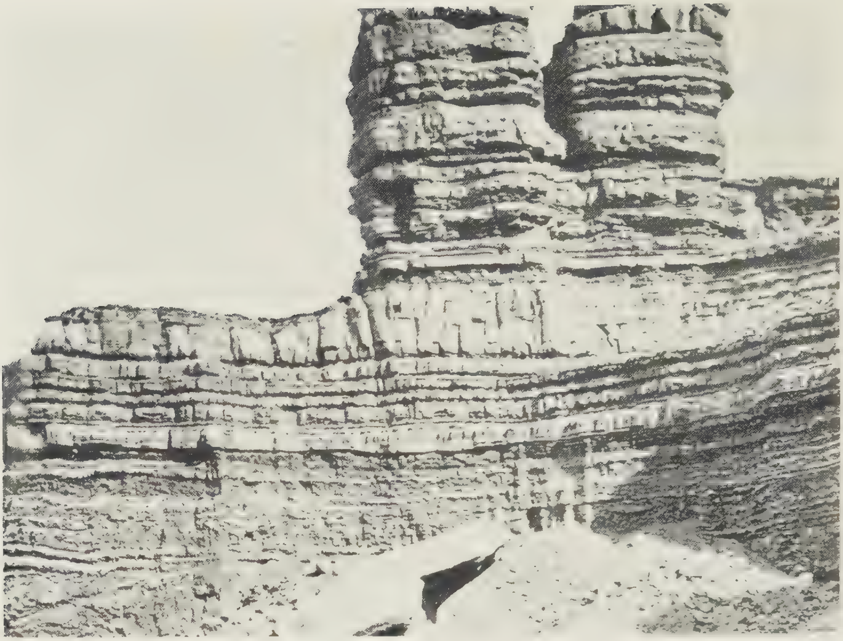

FIG. 5

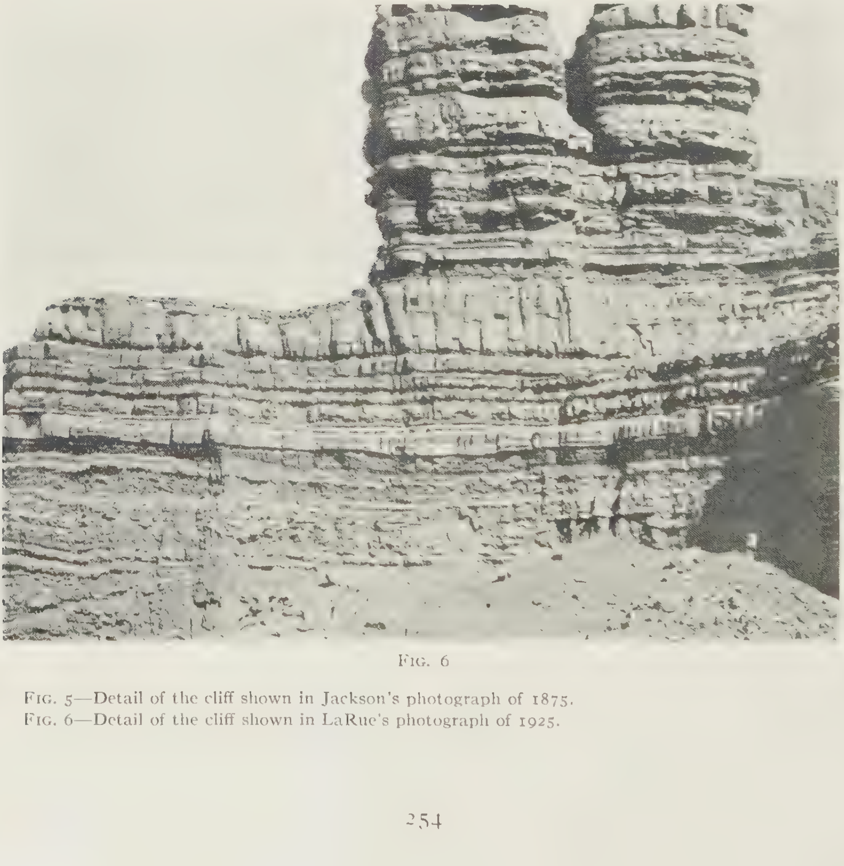

FIG. 6

FIG. 5—Detail of the cliff shown in Jackson's photograph of 1875.
FIG. 6—Detail of the cliff shown in LaRue's photograph of 1925.

the block was carried away for building material. Similarly, the blocks lying on the slope at the foot of the cliff (Fig. 1) have been mostly carried away, and one of the promontories to the left of the Twins in Figures 1 and 2 was blasted down for building stone. Many loose blocks on this slope, however, as may be seen by comparison of the two views Figures 5 and 6, have not moved appreciably in fifty years in spite of the interference of man and all the rainstorms of the intervening time.

The cliff that supports the pillars has every appearance of ruinous decay. The thin bands of shale, sandstone, and limestone are typically "weak" in resistance to weather, and it is customary to think of them as wasting rapidly under its influence. However, an inspection of Figures 5 and 6, enlargements of the photographs of 1875 and 1925 respectively, shows no detectable change in the intricate carving of the cliff. There are slight differences in the shape of the shadows, which may be attributed to the slightly different positions of the sun when the photographs were taken.

Climate As Affecting Local Erosion

There is only a fragmentary record of the rainfall at Bluff. According to the latest compilation of the United States Weather Bureau, the record extends from 1911 to 1920, with only 4 complete years; and the mean rainfall is 6.57 inches. Aneth, 20 miles upstream at an elevation of about 4800 feet and therefore only 500 feet higher, has a somewhat broken record of 14 years from 1900 to 1913 with 9 complete years, and the mean is 7.00 inches. The lowest rainfall for a year of complete record was 4.00 inches, and the highest 10.74 inches. In this region months with no rain are common, and the highest total for any month at either Aneth or Bluff is 2.48 inches. Long droughts and widely separated torrential rains are characteristic of the climate. The mean temperature at Aneth is 54.3° F., but the range in temperature from the highest observed, 106° F. to the lowest observed, 29° F., together with a daily range of 40° to 50°, is evidence of a severity of climate not only hard on vegetation but also favorable for the mechanical disruption of rock by temperature changes and by frost action since the air temperature, especially in winter, frequently crosses the frost line.

The Navajo Twins bear witness to an extremely slow rate of weathering and removal of material. It is true that at other places rock falls have taken place since white settlement. In the Chaco Canyon region, 75 miles southeast, Dodge[2] has recorded the fall from a cliff of a great slab which carried away part of a prehistoric ruin. In

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[2] R. E. Dodge: An Interesting Landslide in the Chaco Cañon, New Mexico (abstract), *Annals New York Acad. of Sci.*, Vol. 15, 1904, pp. 49–50, and *Science*, Vol. 15 (N. S.), 1902, p. 746; *idem:* Arroyo Formation, *Amer. Geologist*, Vol. 29, 1902, p. 322.

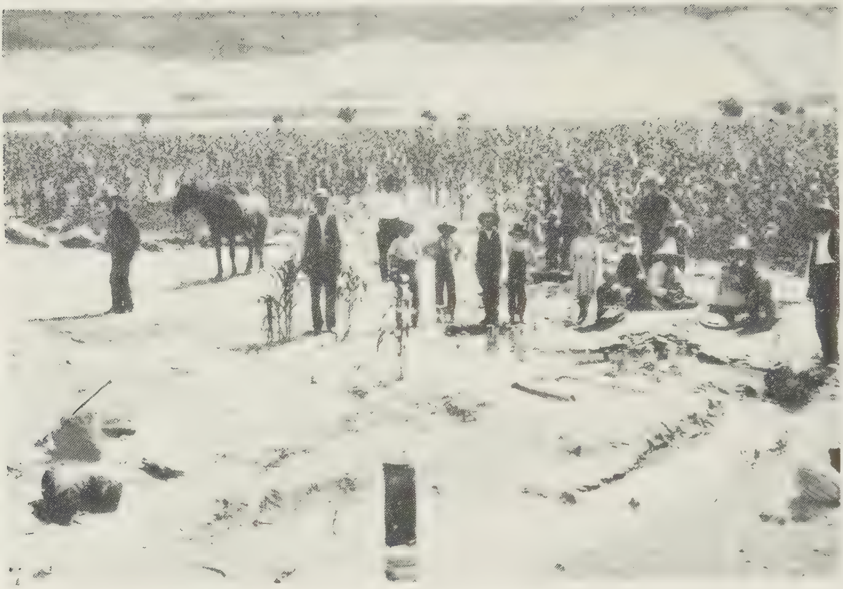

Fig. 7

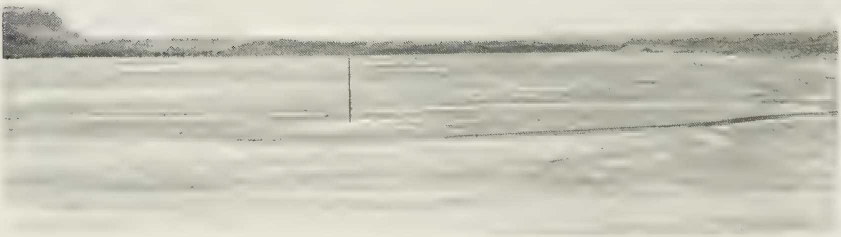

Fig. 8

Figs. 7 and 8—Photographs illustrating the violence of stream action in the San Juan region. Figure 7 shows an artesian well and cornfield near Bluff, Utah, in 1911. The channel of the San Juan River lies between cottonwoods and the bluff. Figure 8 shows the same spot in 1925. The cornfield has been washed away, and the channel of the river has increased in size. The casing of the well is seen projecting from the stream bed.

the same region staircases cut in cliff faces and rock carvings have been partly destroyed by weathering. But the prehistoric relics that remain are numerous, and their creators, however long ago it may have been since they lived in the region, saw the same cliffs and for the most part the same details of their architecture.

Violence of Stream Erosion

The impression gained by a traveler in the area that violent and rapid erosion is in full swing is caused principally by the activities of streams. Violent and spectacular as their floods may always have been, the streams of this region have recently begun to deepen and widen their channels. In the San Juan region the evidence indicates that this change began about 1860.[3] On San Juan River the results of this process are spectacular. The deepened channel of the river is widening and destroying the old flood plain by lateral cutting. In 1911, near the Navajo Twins, there was a fine cornfield irrigated by an artesian well (Fig. 7). In 1925 the field had been washed away, and a total of 425 acres of land had been destroyed. The casing of the well now projects from the sandy bed of the stream (Fig. 8). Such spectacular events draw the observer's attention, but the weathering of the cliffs obeys other laws and yields results at a slower rate.

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[3] Kirk Bryan: Date of Channel Trenching (Arroyo Cutting) in the Arid Southwest, *Science*, Vol. 62 (N. S.), 1925, pp. 338–344.

THE GREAT LAKES-ST. LAWRENCE WATERWAY

Philip W. Henry

THE varied and often sharply opposed regional interests of our country have found expression in sectional groupings of great interest to the geographer. At present, for instance, a new form of sectionalism is exhibited in the Great Lakes Waterway controversy.[1] Before our Supreme Court we see Wisconsin, Minnesota, Michigan, Ohio, Pennsylvania and New York arrayed against Illinois, Missouri, Kentucky, Tennessee, Arkansas, Mississippi, and Louisiana, over the right of Chicago to divert into the Mississippi basin four per cent (10,000 cubic feet per second) of the outflow of the Great Lakes and thus to reduce the levels of Lakes Michigan and Huron six inches, Lakes Erie and Ontario five inches, and the St. Lawrence River at Montreal four inches. While this diversion, which has been going on in substantial amount for twenty-five years, was made chiefly to protect the water supply of Chicago, the drainage canal through which the diverted water passes is an important link in the Lakes-to-Gulf Waterway; and the water taken from the Lakes has a potential capacity of 100,000 horse power in the valleys of the Des Plaines and Illinois Rivers, compared with four times that amount if allowed to flow down the Niagara and St. Lawrence Rivers—its natural channel.

In the Bill of Complaint, dated October 15, 1926, filed by the State of New York in its suit before the U. S. Supreme Court against the State of Illinois and Sanitary District of Chicago, it is stated that "a flow of ten thousand cubic feet per second of water through the Niagara river and the international section of the St. Lawrence river is capable of developing approximately four hundred thousand horse power. The right to use this water for the development of power is a property right of the State of New York and its citizens, which property right neither the defendants nor the Congress of the United States has a right to destroy or impair by abstracting or diverting water from Lake Michigan or any other part of the Great Lakes and St. Lawrence waterway into the Mississippi waterway." . . . "As the result of such abstraction, the mean level of the water . . . has been lowered not less than six inches below the level that would exist in said lakes and waterways in the absence of such abstraction. . . . For every inch of the normal draft of said vessels which they are unable to use because of the reduction in the navigable capacity of the Great Lakes waterway, their cargo carrying capacity is reduced by many tons with the resulting increase in freight costs per ton which becomes a burden upon the complainant state in its proprietary capacity and upon . . . many thousands of people."

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[1] See, for instance, F. J. Turner: The Significance of the Section in American History, *Wisconsin Mag. of Hist.*, Vol. 8, 1925, pp. 255–280.

International Relations

Not only are the interests of various States of the Union involved, but Canada, which borders on the Great Lakes-St. Lawrence Waterway, is also concerned. Early in the nineteenth century the United States was in dispute with Canada over free communication to the sea by the St. Lawrence River, a right not recognized until 1871. The phenomenal growth of population and industry in the area tributary to the waterway that dates from about that time has created an increasingly acute situation.

In 1903 the United States and Great Britain formed the International Waterways Commission, which made a study of the whole problem with especial attention directed to the use of water at Niagara Falls and Chicago. This investigation led to the Boundary Water Treaty of May 13, 1910, which permits the utilization of 20,000 cubic feet of water per second at Niagara Falls by the United States and 36,000 cubic feet by Canada. Although the treaty says nothing specific about the diversion at Chicago, one of the articles classes Lake Michigan as a tributary to boundary waters. Another article permits diversion from such tributaries; but if injury should result from such diversion, then the injured party is given the same legal remedies "as if such injury took place in the country where such diversion or interference occurs; but this provision shall not apply to cases already existing." In explaining to the Senate Committee on Foreign Relations why Canada was allowed the greater amount of water at Niagara Falls, Mr. Root, Secretary of State, said, "Then there is this further fact why we could not object to this 36,000 provision on the Canadian side. We are now taking 10,000 cubic feet a second out of Lake Michigan at Chicago, and I refused to permit them to say anything in the treaty about it."[2] Chandler P. Anderson, legal adviser of the State Department, in a memorandum prepared for the Senate Committee on Foreign Relations said, "Attention is called to the express provision in this Article (II) that it shall not apply to cases already existing, which would seem to cover, and was certainly intended to cover, the canal system of Chicago." Apparently, therefore, Canada has acquiesced in Chicago's taking 10,000 cubic feet per second out of the drainage system of the Great Lakes; but the states of our own country that are adversely affected evidently prefer to have the question settled by our Supreme Court.

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[2] Proceedings of the Committee on Foreign Relations, United States Senate. From the Fifty-seventh to the Sixty-second Congress, inclusive. Printed for the use of the Committee on Foreign Relations, Washington, 1913, p. 272.

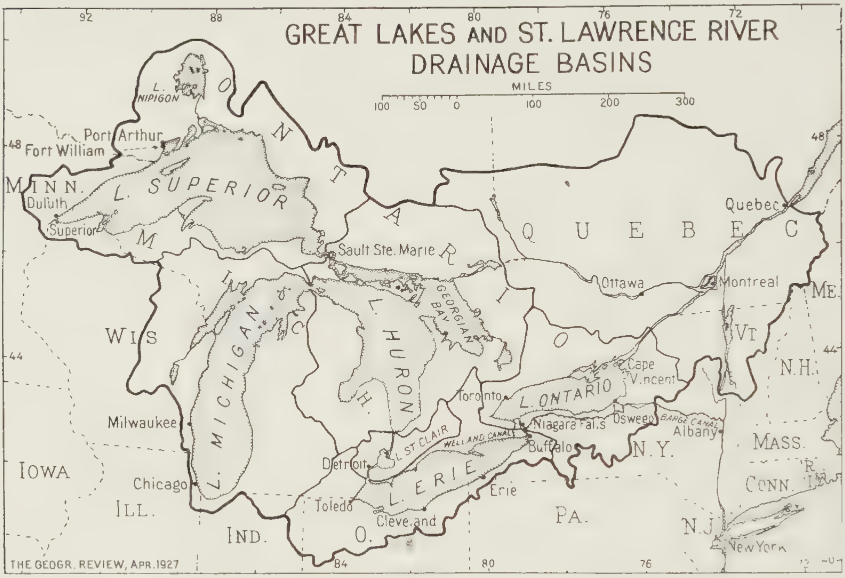

FIG. 1—Map showing drainage basins of the Great Lakes and St. Lawrence River. A heavy line encloses the entire area; lighter lines separate the individual basins. The watersheds of the Great Lakes basins are from the most recent data of the United States Lake Survey.

In addition to the Great Lakes-St. Lawrence waterway the map indicates two other routes which it has been proposed to develop: a ship canal from Oswego on Lake Ontario to the Hudson via the New York State Barge Canal and the Georgian Bay ship canal via the Ottawa River. Scale of map 1:16,000,000.

ENGINEERING REPORTS

In order to solve this complicated problem in justice and equity to all concerned, the facts of the case must be ascertained; and it is fortunate that we have reports of two bodies of engineers bearing on the subject. The first is dated January 23, 1925, and is the "Report of the Engineering Board of Review of the Sanitary District of Chicago on the Lake Lowering Controversy and a Program of Remedial Measures."[3] This Board was composed of twenty-eight of the leading engineers of the United States. Only two of them came from Chicago, the others from twenty-one different cities, north, south, east, and west. It is therefore evident that there was no local bias in their report, which was unanimous. The other report, dated November 16, 1926, is the "Report of Joint Board of Engineers on St. Lawrence

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[3] Report of the Engineering Board of Review of the Sanitary District of Chicago on the Lake Lowering Controversy and a Program of Remedial Measures, Part II: The Technical Bases for the Recommendations of the Board of Review, January 23, 1925.

Waterway Project."[4] This Board was composed of three members appointed by the United States Government and three members appointed by the Canadian Government.

THE DRAINAGE BASIN

The map entitled "Great Lakes and St. Lawrence River Drainage Basins" (Fig. 1) shows the area under consideration. The drainage area of the Great Lakes in square miles and the elevation in feet are shown in Table I.

TABLE I—DRAINAGE AREA AND ELEVATION OF THE GREAT LAKES*

(Areas in square miles; elevations in feet)

LAKE	WATER SURFACE		ENTIRE DRAINAGE BASIN			HEIGHT ABOVE SEA LEVEL	DROP IN ELEVATION
	U. S.	CANADA	U. S.	CANADA	TOTAL		
Superior	20,710	11,100	37,420	43,280	80,700	602.2	Summit
Michigan	22,400		69,040		69,040	581.1	21.2
Huron	9,110	13,900	24,990	47,610	72,600	581.1	
St. Clair	180	280	2,310	4,110	6,420	575.6	5.5
Erie	4,990	4,950	23,570	11,110	34,680	572.5	3.1
Ontario	3,560	3,980	18,720	15,920	34,640	246.1	326.4
Total	60,950	34,210	176,050	122,030	298,080		356.2

*Figures from Survey of Northern and Northwestern Lakes, Bull. No. 35, War Dept., Corps of Engineers, 1926. Connecting waterways are included in the drainage areas as shown on the map, Figure 1.

These figures show that 59 per cent of the drainage area (land and water) of the Great Lakes is in the United States and 41 per cent in Canada. This same proportion pertains practically to the entire drainage area of the Great Lakes and of the St. Lawrence River above the international boundary line. Lake Michigan, the drainage area of which lies wholly within the United States, furnishes about 25 per cent of the flow of the Niagara River.

Broadly speaking, the waters of the Great Lakes have a threefold use: for sanitation (water supply and sewage disposal), navigation, and power. It may be noted that six cities of over half a million population each, as well as a host of lesser places, draw their water supply directly from the lakes. Control of this vital utility, with the allied matters of sewage disposal and drainage, presents different problems in different parts of the region. Cleveland, for instance, must draw her water from far out in Lake Erie because of its shallowness. At Detroit and Buffalo and to some extent at Milwaukee there is a current that carries away the sewage and prevents its contaminating the water supply. By far the most serious problem arises at the upper end of Lake Michigan. Around this dead end of the Lake a dense population has gathered: today what is practically a single urban agglomeration stretches from Evanston to Gary.

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[4] St. Lawrence Waterway: Report of the Joint Board of Engineers Appointed by the Governments of the United States and Canada on the Improvement of the St. Lawrence River Between Lake Ontario and Montreal and on Related Questions Referred to the Board by the Two Governments, Washington, 1927.

Chicago Drainage Canal

In consequence of this lack of current in the Lake a canal has been cut through a low and rather narrow ridge; and the sewage and manufacturing wastes, well diluted with water from the Lake, are discharged into the Des Plaines River and finally reach the Mississippi through the Illinois River, a short distance above St. Louis (Fig. 2). With this exception, all other water taken from the Great Lakes is returned to the same watershed farther down.

The idea of connecting Lake Michigan with the Mississippi River is not a new one. The French explorers Joliet and Marquette as early as 1673 discussed the building of a canal to connect Lake Michigan with the Illinois River. The United States had such a canal under consideration in 1808, and in 1827 gave a land grant to the State of Illinois to permit its construction. In 1848 this canal, six feet deep, was completed at a cost of $6,000,000. It was fed partly by gravity flow from the Calumet River and partly by water pumped from the South Branch of the Chicago River—the first diversion of water from Lake Michigan to another watershed. In 1871 the city of Chicago, in order to reduce the pollution of the Lake, deepened this canal at the expense of $3,000,000 so as to provide a constant gravity flow (700 cubic feet per second) to Lockport on the Des Plaines River, 28 miles distant. With the rapid growth of the city, the question of sewage disposal became vitally important; and in 1886 a Drainage and Water Supply Commission was appointed to make a thorough study of water supply, sewage disposal, and drainage. This Commission made a report in January, 1887, in which it recommended a program that would eventually take care of a population of 2,500,000 people, or three times the population at that time. This program contemplated the construction of a drainage canal with an ultimate capacity of 10,000 cubic feet per second; and in 1889 the Sanitary District of Chicago was created to provide for the disposal of the sewage of Chicago and contiguous territory. The original Act provided that at all times the channel should carry a flow of at least 3⅓ cubic feet per second per 1000 population in the district drained by such channel. With the present District population of

3,426,000 this would mean a diversion of 11,400 cubic feet per second, somewhat more than the actual flow—which in 1924 was 9465 cubic feet—but not really sufficient to keep the Chicago River from reversing itself during storms and thus allowing the sewage to discharge into the Lake and endanger the water supply. The Engineering Board of Review believes that with a flow of 10,000 cubic feet per second under proper management, these reversals can be held to low velocities and short periods of time. Up to date over $100,000,000 have been spent on the project, which began to function in 1900, when the Sanitary District had a population of 1,640,000.

Right to Divert Water

When the Drainage Canal was first constructed, the Trustees of the Sanitary District did not consider that permission of the Federal Government was necessary for the diversion of Lake water but that control was lodged with the State of Illinois, which, under acts of Congress passed in 1822 and 1827, presumably had the right, for purposes of navigation, to divert water from Lake Michigan to the Illinois River. With this understanding the Sanitary District has been working under permits issued by the state, under which the Sanitary District would now be authorized to take 10,947 cubic feet per second. As the Federal Government would not admit this authority, the Sanitary District, on application to the War Department, was permitted in 1901 a diversion of 4167 cubic feet per second.

In 1912 the Sanitary District requested permission to take 10,000 cubic feet per second, which was refused; and in return a suit was brought to enjoin the District from taking more than 4167 cubic feet per second. This suit went to the Supreme Court and was finally decided in favor of the Federal Government on January 5, 1925, "without prejudice to any permit that may be issued by the Secretary of War according to law." Under this decision the Secretary of War issued on March 3, 1925, a revokable permit for an average yearly flow of 8500 cubic feet per second for sewage dilution, subject to various conditions. It required the Sanitary District to construct extensive sewage treatment works and river control works within five years and to meter its water service within ten years, thus lessening the amount taken for water supply[5] (1200 cubic feet per second) and so reducing the volume of sewage to be treated. This permit will expire December 31, 1929, unless specifically extended. Since 1921 over $40,000,000 have been spent for the treatment of sewage so as to lessen the amount of water required for dilution. Plans are now under way for the expenditure of $150,000,000 more for the same purpose, the cost to be distributed over the next fifteen to twenty years.

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[5] The present per capita consumption in the city of Chicago is 280 gallons daily, an excessive amount. See J. M. Goodell: The Secretary of War's Concern over Water Waste at Chicago, *Journ. Amer. Waterworks Assn.*, Vol. 13, 1925, pp. 556–587; reference on p. 580.

The Engineering Board of Review, in relation to this program, says "Until the above stated program is substantially completed it is essential, in the interest of the public health, to maintain an average annual diversion of about 10,000 cubic feet per second of Lake water."[6]

Whatever may be the outcome of litigation now in progress between various states of the Union concerning this diversion, it is evident that Chicago can no longer depend on taking additional water from Lake Michigan for the dilution of her sewage and that she will be fortunate if she can permanently hold the 8500 cubic feet under the present permit. With evident appreciation of this situation, the Sanitary District in 1918 made an offer to the Federal Government to pay the cost of remedial works made necessary by its diversion of water from Lake Michigan.

Lakes-to-Gulf Waterway

The Drainage Canal is not only useful for the disposal of sewage through dilution with seven times its amount of Lake water, but it forms an important link in the Lakes-to-Gulf Waterway, of which it provides the most costly section. The State of Illinois is spending $20,000,000 in constructing the next most expensive section; and when this is completed there will be a 9-foot barge waterway with five locks, extending from Lake Michigan to the Illinois River at Utica, Ill., about 100 miles. From the lower end of the section now being constructed by the state, the United States maintains 6- to 9-foot navigation over the remaining distance to the Gulf of Mexico and has under consideration a 9-foot project, similar to the Ohio River improvement. While, in the opinion of the Engineering Board of Review, it would be physically possible to construct such a 9-foot waterway without any diversion of water from Lake Michigan, its cost between Lockport and the mouth of the Missouri River would be $30,000,000 more than it would be with a diversion of 10,000 cubic feet per second of Lake water, and the waterway would be less efficient.

Effect of Chicago Diversion on Power

The Drainage Canal is valuable to Chicago and Illinois not only for sanitation and navigation but also for the production of power. The Lockport power plant on the Drainage Canal was completed in 1907 and utilizes under a head of 34 feet the power contained in the water that flows through the Drainage Canal. This plant has carried a peak load of 31,000 horse power, and the gross income from the whole

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[6] Report of the Engineering Board of Review, Part II, p. 34.

Sanitary District electrical system, of which Lockport is the larger portion, is somewhat over $1,000,000 annually, with a net income of $250,000 after allowing for interest and depreciation. Some 70,000 horse power additional can be produced in the Illinois valley, all of which can be marketed within a few miles of the power stations.

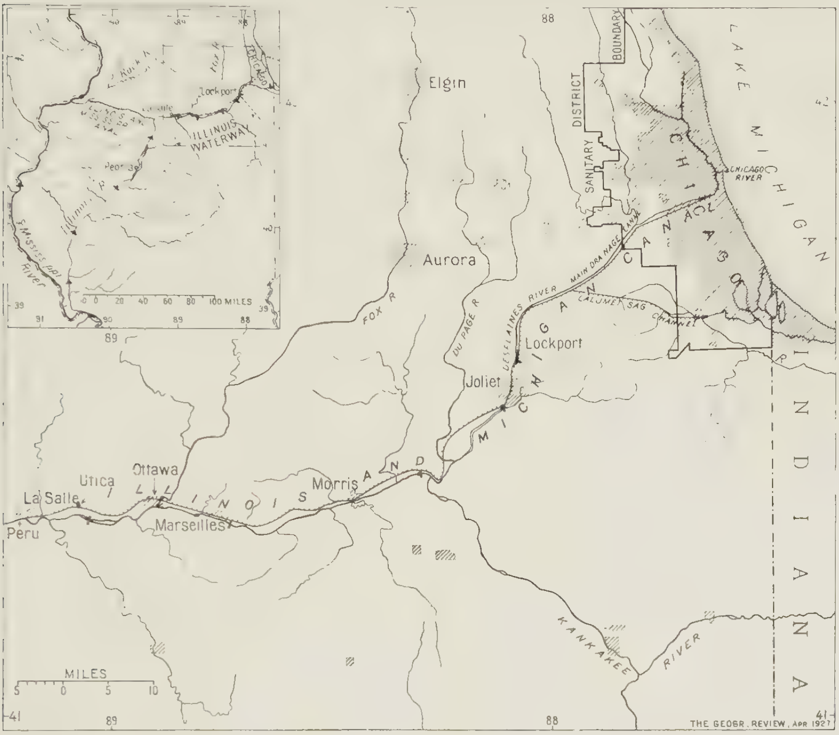


FIG. 2—The Sanitary District of Chicago, the Chicago Drainage Canal, and the Illinois Waterway. The Illinois and Michigan Canal, shown in conventional symbol, parallels the Desplaines River and the Illinois River, which is formed by the union of the Desplaines and Kankakee Rivers. The so-called Illinois Waterway is that section of the Lakes to Gulf Waterway connecting the Drainage Canal at Lockport with the navigable waters of the Illinois River at Utica. Note the contiguity of the municipalities on the Lake Michigan shore: from Evanston, Ill. to Gary, Ind. is practically a single "conurbation." Scale of map 1:1,350,000.

The inset map shows relations between Drainage Canal and Illinois Waterway and the navigable Illinois River. Scale of map 1:10,000,000.

The available net head of the diverted water is 122 feet, compared with 305 feet at Niagara Falls. However, as power commands a much higher price in the former region than it does in the latter, the Engineering Board of Review concludes that "the actual monetary value of a cubic foot of water per second for power purposes in Illinois is greater than at Niagara" and "the Chicago diversion causes no economic power loss." In other words, 100,000 horse power developed by 10,000 cubic feet per second in Illinois would be worth as much as 250,000 horse power developed by the same amount of water at Niagara Falls.

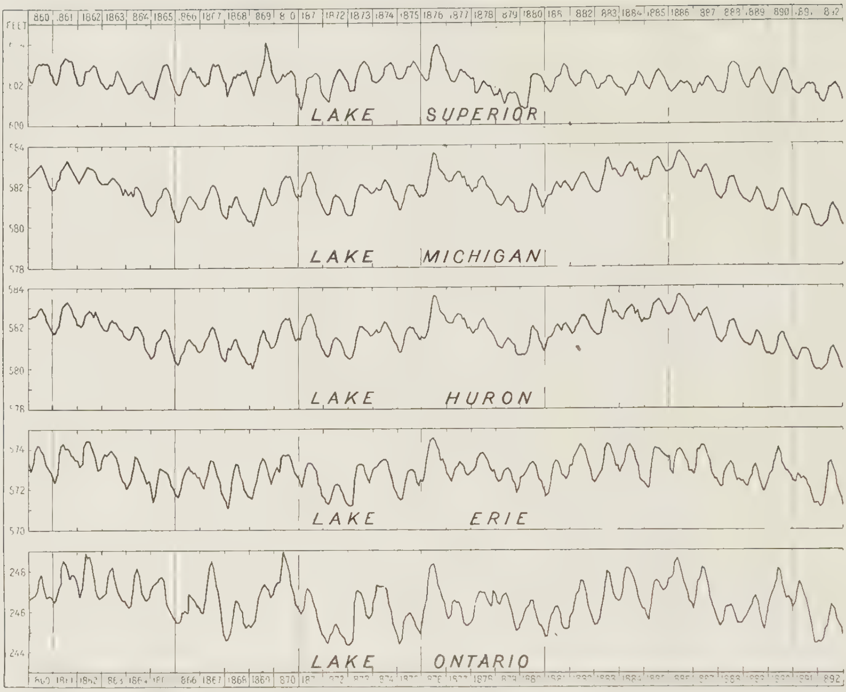
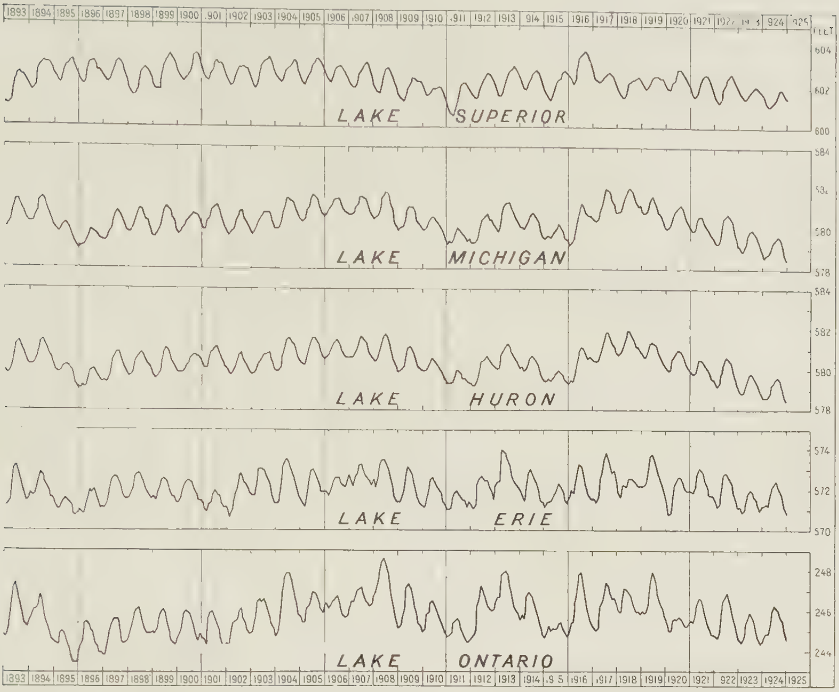


Fig. 3—Fluctuations in the levels of the Great Lakes from 1860 to 1924.

Under the treaty between Great Britain and the United States, which allows 56,000 cubic feet of water per second for power purposes at Niagara Falls, there could be produced, under the net available head of 305 feet, over 1,500,000 horse power. As the present power plants utilize only two-thirds of the net head available, there is now a constant loss of 500,000 horse power. It would therefore appear that the Chicago diversion does not now affect the power situation at Niagara Falls and will not for many years to come. Considering, however, that the purpose of the two Governments in restricting power utilization was to preserve the beauty of the Falls, it may be argued that if there were no diversion at Chicago, the restriction could be raised 10,000 cubic feet per second without changing the present aspect of the Falls.

In regard to the St. Lawrence River, the total available fall is 200 feet, with a gross available horse power of 5,000,000, which compares with a present production of 300,000 horse power on both sides of the river. Inasmuch as the amount of water diverted at Chicago is only 4 per cent of the total flow of the St. Lawrence, it is evident that this diversion will have no effect on the power there until the rest of the flow has been utilized. The Joint Board of Engineers finds that "after the St. Lawrence River has been fully developed for power



Elevation in feet above mean sea level. From the U. S. Lake Survey.

production no works can be constructed which would recover on the St. Lawrence the power lost by the diversion of water from the watershed."[7]

Effect of Chicago Diversion on Water Levels

From what has preceded it is evident that the diversion of water from Lake Michigan by the Sanitary District of Chicago has been of particular benefit to that city and of general benefit to Illinois and other states tributary to the Lakes-to-Gulf Waterway. On the other hand, this development has created situations that may well be prejudicial to the interests of other states and of Canada. Shortly after the Drainage Canal began operations, the city of St. Louis brought suit on the ground that her water supply, taken from the Mississippi River, would be contaminated. However, scientific investigation and analyses of water taken from the Illinois River showed such effective purification en route that St. Louis lost her suit. More serious were the complaints about the lowering of the Great Lakes and the St. Lawrence River through this diversion into another watershed, for the Great Lakes support a traffic of 100,000,000 tons a season, and more tons of freight pass Detroit in the eight open months than pass through both the Suez and Panama Canals in two years. As most of the cargoes consist of grain, ore, coal, and limestone, which can be loaded, transported, and discharged in bulk, this Lake transportation is the cheapest in the world, with freight rates usually less than one-tenth of a cent per ton per mile, and in some instances only one-third of that amount. It is estimated that the loss caused by the reduction of a foot in the available draft of a bulk freighter in the upper Lakes would amount to $6,000,000 a year for the entire fleet.[8] To determine the effect of all Lake diversions on water levels and on the development of power, and to prescribe remedies therefor, were largely the reasons for the appointment of the two engineering bodies referred to.

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[7] Report of the Joint Board of Engineers, p. 44.

These two Boards are not far apart in their conclusions concerning the effect on Lake and River levels. The Engineering Board of Review says "If an annual average flow of 10,000 cubic feet per second passes from Lake Michigan into the Drainage Canal, and no provisions are made to hold back part of the storm water entering the Lakes for discharge during dry periods, then this diversion will eventually produce a small permanent lowering of all Lakes except Superior. The lowering by reason of the diversion will be greatest in Lake Michigan-Huron, where it will never exceed 6 inches. To this extent it will affect the draft to which the largest lake vessels can be loaded, unless measures are taken to restore the natural lake level."[9]

The Joint Board of Engineers, which assumes 8500 cubic feet per second as the maximum amount of diversion allowed for sewage dilution, says: "The diversion by the Chicago Sanitary District of 8500 cubic feet per second from the lake basin through the Chicago Drainage Canal, authorized by license by the United States, lowers the water levels on the Great Lakes and the St. Lawrence River as follows: Lakes Michigan and Huron 0.5 foot, Lake Erie 0.4 foot, Lake Ontario 0 4 foot, St. Lawrence River at Montreal 0.37 foot, at Quebec 0.03 foot."[10]

Other Causes Affecting Lake Levels

Broadly speaking, the lowering caused by the Chicago diversion is a small matter when compared with daily, seasonal, and yearly fluctuations in the levels of the Great Lakes. In addition to the seasonal range, which averages between one and five feet in each lake between the winter low stage and summer or early fall high stage, there are the day-by-day and the yearly variations. The Lake surfaces change constantly under the influence of winds and changing barometric pressure. Usually these changes are small in amount,[11] but seiches have occurred in Lake Erie with a difference of 12 feet in elevation between the two ends of the Lake. Irregular changes also occur during exceptional ice conditions. In severe winters there is a very marked retardation of flow in the St. Clair and Detroit Rivers. No definite cycle is recognized in the yearly changes of the lakes. These fluctuations are shown for each lake separately in the chart, Figure 3, while Figure 4 gives a composite picture of the yearly variation. The notable lowering of the last decade has aroused much discussion, and the prime cause is well explained in the words of the Weather Bureau which lately carried out an investigation into the relation between precipitation in the drainage basin of the Great Lakes and Lake levels in the last 50 years.

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[8] Col. J. G. Warren, in a report of Aug. 30, 1919.

[9] Report of the Engineering Board, Part II, p. 65.

[10] Report of the Joint Board of Engineers, p. 42

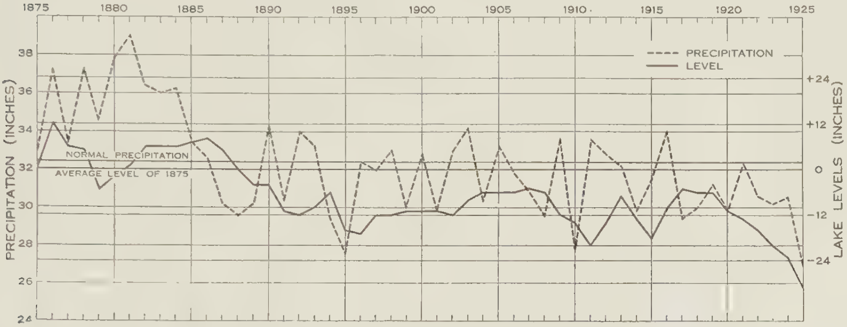

FIG. 4 —The relation between precipitation and lake levels, 1875–1924. Variation from the normal mean level of Lakes Superior, Huron, Michigan, and Erie in inches is shown by a solid line; precipitation, in inches, is shown by a dashed line. Reproduced from the *Monthly Weather Review*, Vol. 54, 1926, p. 100 (see footnote 12).

"The precipitation was unusually heavy, on the average, from 1875 to 1885, and the period 1875 to 1899 shows more precipitation at almost every station than the period 1900 to 1924. However, there were groups of a few successive years with scanty precipitation before 1900, one, indeed, before 1890. From 1917 to the present nearly the whole area has had decidedly scanty precipitation. It is not believed that removal of the forest cover has materially affected the amount of water reaching the lakes.

The water levels seem to be closely related to the quantity of precipitation, delays of a year or more often appearing in the response of the levels, since the run-off is not immediate. It is highly improbable that the deficient falls of recent years indicate permanent or semi-permanent establishment of scanty supplies of precipitation. A return over several years to the normal quantity of precipitation or to even greater amount may be expected to end the present prevalence of unusually low levels in the lakes, just as various periods of low water during the nineteenth century were terminated by generous rainfall."[12]

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[11] See, for instance, J. F. Hayford: Effects of Winds and of Barometric Pressures on the Great Lakes, *Carnegie Instn. Publ. No. 317*, Washington, 1922.

[12] P. C. Day: Precipitation in the Drainage Area of the Great Lakes, 1875–1924, with Discussion of the Levels of the Separate Lakes and Their Relation to the Annual Precipitation, *Monthly Weather Rev.*, Vol. 54, 1926, pp. 85–101; reference on p. 85.

The Engineering Board of Review points out that the mean levels of the Great Lakes during recent years average about 2½ feet lower than six or eight years ago, and on Lakes Michigan and Huron 4 feet lower than thirty-eight years ago, and gives a list of causes for this condition as in Table II.

TABLE II—CAUSES OF THE PRESENT LOW LEVELS OF LAKES MICHIGAN AND HURON[13]

1.	Unusually light rainfall combined with unusually large evaporation during the five years, 1919 to 1923	13 inches
2.	The fall from Lake Huron to Lake Erie along the St. Clair and Detroit Rivers during 1897–1923, inclusive, averaged less than in 1860–1885, inclusive. This explains a lower stage of Lakes Michigan and Huron by	8 "
3.	Diversion of water from Lake Michigan at Chicago	5 "
4.	Retention by the existing regulating works of water in Lake Superior which would otherwise have flowed into the lower lakes	3 "
5.	Diversions of water from Lake Erie and from the Niagara River by the Welland Canal, the New York State Barge Canal, the Black Rock Navigation Canal, and the power canals at Niagara Falls, which have lowered Lake Erie about 4.4 inches and thus by backwater effect through the Detroit and St. Clair Rivers have lowered Lakes Huron and Michigan	2 "
	Total lowering of Lakes Michigan and Huron below normal	31 "

To Table II we may add Table III from the report of the Joint Board of Engineers. It shows the effect of various works already constructed, and of the new Welland Canal, now approaching completion.

From these two tables it is evident that the reduction in levels of Lakes Michigan and Huron due to the Chicago diversion is less than that due to dredging in the St. Clair and Detroit Rivers; but, while the former work is a detriment to navigation in general, the latter is a benefit. The effect on Lake Erie of the Chicago diversion is little more than half that which will be due to the new Welland Canal when completed; but the latter, too, will be a benefit to navigation in general.

RESTORATION OF LAKE LEVELS

Both Boards of Engineers conclude that lake levels can practically be restored, but the boards do not agree as to the type of works that should be adopted. For raising lake levels in general there are two kinds of construction, viz. regulating works and compensating works. Regulating works control the discharge from lakes and thus permit the release of water stored in years of abundant rain to increase the flow in years of scanty rain; compensating works are designed merely to impede the flow and thereby raise both high and low water stages without eliminating fluctuations caused by excessive or insufficient rains.

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[13] Report of the Engineering Board of Review, Part II, p. 74.

The Engineering Board of Review recommends the construction of regulating works, which will raise the level of the lake and river surfaces, thus increasing depth of navigation channels, and which will also store, conserve, and release water for increased development of water power and increased depths in the lower St. Lawrence River. The Board says "It is practicable, by means of regulating works at the outlets of Lakes Erie and Huron together with the existing works at the outlet of Lake Superior, to maintain under all ordinary conditions a minimum flow in the Niagara River of from 180,000 to 200,000 cubic feet per second, while also providing depths for navigation averaging 2 feet greater than those under the unregulated natural conditions prior to the Chicago diversion."[15] The Board points out that the regulating works at the outlet of Lake Superior, finished in 1916, show the feasibility and practicability of such works. No estimate of cost of the proposed regulating works is made, but plans and estimates are in the course of preparation.

TABLE III—EFFECT OF SEVERAL CONSTRUCTIONS IN LOWERING LEVELS OF LAKES[14]

(*In feet*)

CONSTRUCTION	LAKES MICHIGAN AND HURON	LAKE ERIE	LAKE ONTARIO
Chicago Sanitary District	0.5	0.4	0.4
New Welland Canal	0.2	0.7	. . .
Black Rock Canal	0.01	0.05	.
Changes in St. Clair Outlet . . .	0.60	. . . .	. . .
Gut Dam	. . . .	. . . .	+0.4
Total Lowering Effect . . .	1.31	1.15	0.0

On the other hand, the Joint Board of Engineers, while recommending regulating works for Lake Ontario, prefers compensating works for Lakes Huron and Erie which will raise their levels 1.0 foot and 0.7 foot respectively, partly because the results that could be secured from regulating works would be incommensurate with their cost. It estimates the minimum cost of regulating works at $36,400,000 and of compensating works supplemented by dredging at $13,400,000. The Board also believes that regulating works in the St. Clair River would interfere with its present intensive traffic, whether a navigable pass or locks be adopted. The practicability of the former is doubtful, and the operation of the latter would mean a delay for vessels, costing upwards of $1,000,000 a year. Then too, the operation of regulating works would tend to prolong the periods of low flow in the St. Lawrence River. This Board also finds that there is no present justification for the great expenditure necessary to provide regulating works in the interest of increasing power on the St. Lawrence River. Another argument against regulating works—political rather than engineering—is given by the Board as follows: "Regulation works could be administered to serve either of two divergent purposes. They could be used to decrease the fluctuations in the lake levels for the benefit of navigation and of riparian interests on the Lakes at the expense of the outflow into the St. Lawrence, or they could be used to improve the outflow into the St. Lawrence for the benefit of power production and of navigation in the lower river at the expense of the levels of the Lakes. The predominant interests concerned in the levels of the Great Lakes are in the United States; the predominant interests concerned in the outflow into the St. Lawrence are in Canada. Lake regulation might, therefore, create points of difference between various interests in the two countries. . . . . If a future deficiency in supply should exceed past records in extent and duration the question would arise whether the emergency should be met by holding back water in the Lakes at the expense of the St. Lawrence, or whether the navigable depth in Montreal Harbor is to be maintained at the expense of lake navigation."[16]

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[14] Report of the Joint Board of Engineers, p. 14.

[15] Report of the Engineering Board of Review, Part II, p. 81.

The Joint Board states that the regulating works at the outlet of Lake Superior have been satisfactory because "the fluctuations introduced in discharge from that lake are absorbed in the great reservoir formed by Lakes Michigan and Huron without greatly affecting the levels of the latter or materially affecting the discharge of the Niagara and the St. Lawrence Rivers."[17] Nevertheless it may be noted that among the causes of the recent low stages of Lakes Michigan and Huron, the Engineering Board of Review attributes 3 inches (half that caused by the Chicago diversion) to "retention by the existing regulating works of water in Lake Superior which would otherwise have flowed into the lower lakes."[18] The Joint Board in explanation of its recommendation of regulating works at the outlet of Lake Ontario, says that this will affect "one lake only, which has but 8 per cent of the area of the Great Lakes system," that it is "proposed as a necessary part of the improvement of the St. Lawrence," and "will not affect in any substantial manner divergent national interests."[19]

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[16] Report of the Joint Board of Engineers, pp. 16-17.

[17] *Ibid.*, p. 17.

[18] See above, Table II.

[19] Report of the Joint Board of Engineers, p. 17.

Cost of Remedying Chicago Diversion

In considering the improvement of lake and river levels, the Joint Board of Engineers has estimated that the cost of eliminating the effect of the Chicago diversion will be as follows:

Proportional cost of compensating works, outlet of Lake Huron . .	$1,350,000
" " " " " " " " Erie . . .	400,000
Cost of restoring levels at and below Montreal	4,608,000
Total cost of eliminating effect of Chicago diversion	$6,358,000

The Board goes on to say that the effect of the Chicago diversion on the levels of Lake Ontario and of the St. Lawrence River above Montreal will be eliminated if the improvements proposed are carried out, but it allots no specific amount chargeable to this diversion. As regards the power lost by the Chicago diversion it should not be difficult to commute its value into capital or annual payments, when occasion may arise—i. e. when the power resources on the Niagara and St. Lawrence Rivers have been fully utilized. This will be a long time off, for it is the present policy to maintain a flow at Niagara Falls, and it is proposed to develop at present only half the potential power in the process of making the St. Lawrence navigable. Besides, there are many streams in this region, both in the United States and Canada, that are rich in water power resources (aggregating 4,000,000 horse power) and that can be developed more in accordance with market requirements, at a cost per horse power not exceeding that on the St. Lawrence.

The St. Lawrence Waterway

Four major proposals for increasing the usefulness of the Great Lakes as a commercial highway are now under consideration in the United States. Reference has already been made to the Lakes-to-Gulf Waterway which involves improvement of the Illinois sections. Other suggestions are for a deep draft connection with the Atlantic by a ship canal from Lake Ontario to the Hudson River, and for a gulf connection by a barge canal from Lake Erie to the Ohio River. These three proposals are now being studied by the United States War Department.[20] The fourth proposal, a deep draft connection with the Atlantic by the St. Lawrence River, is the international project forming the subject of the Joint Board of Engineers' report, which will now be discussed. In passing reference may be made to a revival of interest in the Canadian project of a ship canal to the St. Lawrence from Georgian Bay (see Fig. 1).

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[20] Transportation on the Great Lakes, War Department, Corps of Engineers, U. S. A., and U. S. Shipping Board, Washington, 1926, p. 426.

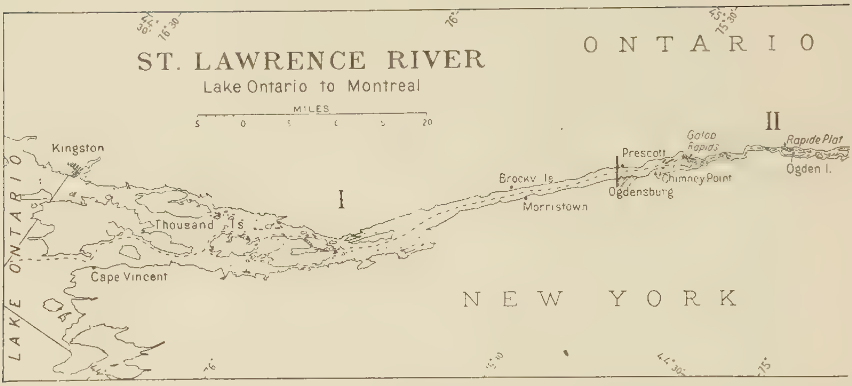
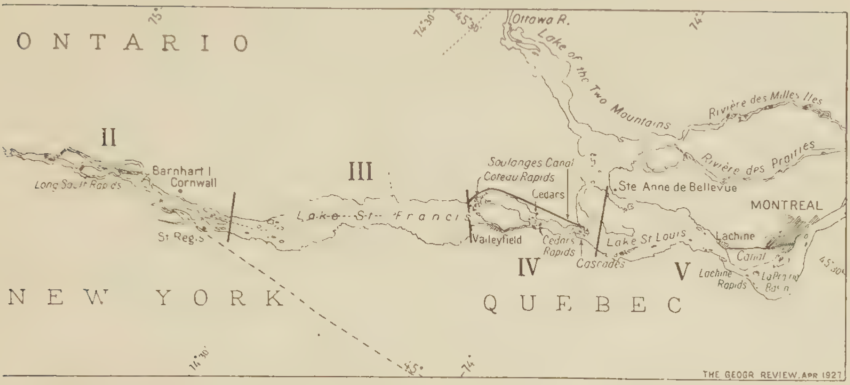


FIG. 5—St. Lawrence River between Lake Ontario and Montreal showing the five natural divisions. Scale approximately 1:1,130,000. Compare with Table IV.

The present navigation of the Great Lakes-St. Lawrence waterway is classified thus:

1. Lake navigation normally operating on a 20-foot draft on all the lakes and between all the lakes except Ontario. The fall in lake levels during the last few years has, however, reduced the available draft; in the latter part of 1925, for instance, it was only 18 feet.
2. Canal navigation, normally operating on a 14-foot draft between Lake Erie and Lake Ontario through the Welland Canal and between Lake Ontario and Montreal through various canals along the St. Lawrence River. The traffic on the St. Lawrence Canals amounted to 6,206,988 tons in 1925.
3. Deep-sea navigation from Montreal to the ocean, 30 feet at present, with 35 feet under way.

The new Welland Canal, with minimum depth of 25 feet and locks constructed for 30 feet, will open Lake Ontario to lake navigation in 1930. There will then remain the 183 miles of the St. Lawrence between Lake Ontario and Montreal, where the river runs in deep slow-flowing reaches and lake-like expansions separated by rapids. Five natural divisions are recognized: the Thousand Islands section, from Lake Ontario to the first swift water at Chimney Point, 67 miles with total fall of only one foot at mean water level; the International Rapids section, to the head of Lake Francis, 49 miles with fall of 92 feet; the Lake Francis section, 26 miles with fall of one foot; the Soulanges section to Lake St. Louis, 18 miles with fall of 83 feet; the Lachine section to Montreal Harbor, 23 miles with fall of 48 feet. Because of these lake reservoirs the flow is remarkably steady and the river free from silt. Except where affected by ice gorging in winter, fluctuations in the surface nowhere exceed a few feet.



Detailed maps (scale 1:55,000) showing proposed improvements accompany the Report of the Joint Board of Engineers (see footnote 4).

The present Joint Board formulated a plan of investigations in April, 1925, following up the work of the Commission of 1921.[21] The United States division devoted special study to surveys and borings in the International section, the Canadian division to research on the loss of heat in the river during the winter and to experiments on the resistance of ice as bearing on construction design.

Cost of Improving Great Lakes-St. Lawrence Waterway

The Joint Board of Engineers, conforming to instructions, based its estimates on a 25-foot depth for channels and a 30-foot for locks and other structures. It also gave consideration to the question whether it would be better to provide initially for a depth other than 25 feet. A majority of the Canadian section favor 27 feet, which is the depth to which the new Welland Canal is being carried under present contracts. A majority of the American section favor 25 feet because a greater depth above Lake Erie is not foreseen for a long period. In this connection it is interesting to note the conclusions expressed in a recent pamphlet issued by the U. S. Department of Commerce entitled "Great Lakes-to-Ocean Waterways," where it is stated: "The conclusion is evident, therefore, that in order to assure proper ocean connection the minimum depth of channels should be 27 feet, thus accommodating vessels of 25-foot draft; such draft would include 54 per cent of American cargo vessels and 88 per cent of all our entrances and clearances. It is felt that restricting operation to any less percentage of ocean-going vessels would materially detract from the usefulness of the proposed waterways."[22]

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[21] See St. Lawrence Waterway, *67th Congr., 2nd Sess., Senate Doc. No. 114*, Washington, 1922.

[22] E. S. Gregg and A. L. Cricher: Great Lakes-to-Ocean Waterways: Some Economic Aspects of the Great Lakes–St. Lawrence, Lakes-to-Hudson, and All-American Waterway Projects, *Bur. of Foreign and Domestic Commerce, Domestic Commerce Ser. No. 4*, Washington, 1927, p. 2.

The initial capacity of the St. Lawrence waterway on a 25-foot depth will be 16,000,000 tons, and the ultimate capacity on this depth 24,000,000 tons—practically the same as present traffic on the Suez Canal and the Panama Canal. There will be not more than 25 miles of restricted canal navigation, with only nine locks and eight bridges. The time of completion will be from seven to eight years.

By combining several of the estimates of the Joint Board, we have the following estimated cost of providing channels 25 feet deep and 27 feet deep, respectively, on the Great Lakes and St. Lawrence River.[24]

	25-foot Channel	27-foot Channel
Locks in St. Mary's River		$6,500,000
Connecting channels on Great Lakes	$41,100,000	54,900,000
Compensating works	3,600,000	3,700,000
St. Lawrence River (no power development)	167,720,000	173,520,000
Total estimated cost	$212,420,000	$238,620,000

This does not include the new Welland Canal, the estimated cost of which is $114,500,000 for 25-foot depth and $115,600,000 for 27-foot depth, borne by the Canadian Government.[25] Although the St. Lawrence River could be improved for navigation alone, as shown in the estimate above, the Joint Board of Engineers says "the improvement of the rapid sections of the river for the joint benefit of navigation and power affords, as a rule, much better navigation

Table IV—Estimated Cost of St. Lawrence Improvement[23]

Section	Solely for Navigation	Primarily for Power	Jointly for Power and Navigation	Total with Complete Initial Power Installation
Thousand Islands	$1,100,000	....	....	$1,100,000
International Rapids	22,000,000*	$106,500,000	$106,500,000	235,000,000
Lake St. Francis	980,000	....	....	980,000
Soulanges	31,594,000	37,665,000	34,686,000	103,945,000
Lachine	53,000,000	....	....	53,000,000
Total	$108,674,000	$144,165,000	$141,186,000	$394,025,000

* Estimate of the U. S. division on a one-stage development. The two-stage development recommended by the Canadian division calls for a first cost of $350,080,000, with production of 1,365,000 horse power, and a total cost of $423,571,000, with production of 2,619,300 horse power.

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[23] *Ibid.*, p. 35.

[24] Report of the Joint Board of Engineers, pp. 18, 19, 36.

[25] *Ibid.*, p. 36.

than could be secured by the improvement now economically justifiable in the interests of navigation alone."[26] Combined with the development of 2,326,000 horse power in the International Rapids section and 404,300 in the Soulanges section, the estimated cost of the St. Lawrence improvement with a depth of 25 feet is as in Table IV.

The cost of additional works to complete the full practical development of the gross available power in the river (5,000,000 horse power) will be $224,420,000, making a total eventual cost of $620,000,000 to $650,000,000 for improving the St. Lawrence River, depending on the form of improvement adopted in the International Rapids section. It may be noted that the first two sections in Table IV lie between the Province of Ontario and the State of New York. The other three are in the Province of Quebec, in which will also be located the additional development of power.

Recommendation for Construction and Operation

The Joint Board of Engineers recommends that all works of permanent construction within the International sections should be done under the technical supervision of a single international board, which would as well coördinate the program of construction all the way from Lake Ontario to Montreal. The Joint Board also regards it essential that an international control board should be created to regulate the use of water at the power plants in the international sections and thus prevent undue interference with power plants and with navigation farther down the river. That such international control is practical is shown in the operation of the regulating works at the outlet of Lake Superior, where the gates are operated and diversions controlled by an International Board of Control established by the International Joint Commission, May 26–27, 1914.[27] The satisfactory working of an international board is further evidenced by the report of the Joint Board itself, which has dealt impartially and effectively with the engineering problems involved. And we have a good omen for the maintenance of harmonious relations between the United States and Canada in the work of the International Boundary Commission and the Joint Commission on Waterways in demarcating the common boundary.

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[26] *Ibid.*, p. 20.

[27] *Ibid.*, p. 11.

THE PHYSIOGRAPHIC INTERPRETATION OF THE FALL LINE*

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WITHOUT exception, regional physiographers have selected the fall line of the eastern United States as a boundary between two major physiographic regions, the Crystalline Appalachians and the Atlantic Coastal Plain. This is due not so much to its physical nature, for the physiographic expression of the fall line is often slight, but to the striking differences in rock structure, soil, vegetation, and types of geographic adjustments on opposite sides of this boundary.

The fall line has also a hydrographic and economic significance, for it marks a point of deflection of or declivity in nearly every stream that crosses it. The falls or rapids in the streams as they cross the fall line interrupt river navigation and before the age of coal power offered some of the prime power sites of the eastern United States. As a result of these two factors, now relatively of less importance, there exists today a long line of cities on or near the fall line; Trenton, Philadelphia, Wilmington, Baltimore, Washington, Fredericksburg, Richmond, Petersburg, Columbia, Augusta, Milledgeville, and Macon—most of them seats of important manufacturing.

The fall line is often traced by railways, telegraph and telephone lines, roads, and county boundaries, and there is present at nearly every point a strong contrast in social types and economic life on opposite sides of it. Yet "the boundary is never a cliff and seldom even a well-defined scarp, and the lowland hills are nearly as rugged and more than half as high as the piedmont hills; [it] is not really a line but a zone of appreciable width; hence 'fall belt' would be a more accurate designation."[1]

THEORIES OF ORIGIN REVIEWED

The following explanations concerning the origin and nature of the fall line have from time to time been advanced by American physiographers: W J McGee attributed the origin of the fall line to monoclinal flexing or faulting,[2] somewhat after the manner indicated in Figure 2. His theory has been accepted by N. H. Darton, N. M. Fenneman, Cleveland Abbe, Jr., and others.[3] But, while faulting does occur near the fall line in one or two localities, there is no evidence of displacement throughout most of its course, and some of the best cases of stream declivity occur in localities where no faulting can be detected.[4] W. M. Davis considers the fall line to be due to the contrast in the gradients established by streams in the resistant rocks of the Piedmont with those developed on the weak rock of the Coastal Plain. "The falls occur where the entrenched river passes from a steeper slope on the resistant rocks of the older land to a nearly level channel excavated in the weak strata of the plain."[5] Figure 3 is essentially that which Davis used to illustrate his theory. In connection with his diagram, Davis gives the following explanation.

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* Prepared in connection with a graduate course in physiography at Columbia University under the direction of Professor Douglas Johnson.

[1] Isaiah Bowman: Forest Physiography, New York, 1911, p. 499. See also p. 623.

[2] W J McGee: Three Formations of the Middle Atlantic Slope, *Amer. Journ. of Sci.*, Ser. 3, Vol. 35, 1888, pp. 120–143.

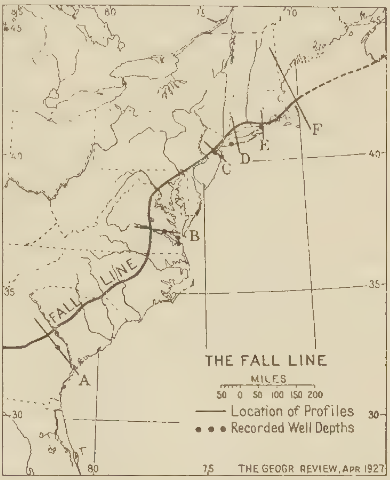

FIG. 1 —Map showing the fall line and the location of profiles and recorded well depths discussed in the text.

Before the area was uplifted the rivers had cut valleys of gentle slope leading to what was then base level—the shore line along the outer edge of the Piedmont. After emergence, the extended rivers rapidly entrenched their lower courses in the nonresistant sediments of the Coastal Plain, whereas downcutting proceeded very slowly in the hard rocks of the Piedmont. These new valleys of the lower courses of the streams worked headward till they encountered the resistant rocks beneath the Coastal Plain near its inner margin, where downcutting was checked. The middle portion of the stream, between the gentle upper reaches on the Piedmont and the gently sloping lower entrenched portion in the Coastal Plain, possesses a relatively steeper slope and hence is marked by falls and rapids.

Davis's theory is clearly based on the assumption that the surface of the Piedmont is continued beneath the sedimentary formations of the Coastal Plain, and a necessary corollary of his theory is that the gradients of the streams in the Piedmont are less than the slope of the upland peneplane surface. T. L. Watson, in drawing a physical cross section of Virginia, follows Davis's theory.[6]

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[3] N. H. Darton: Artesian Well Prospects in the Atlantic Coastal Plain Region, *U. S. Geol. Survey Bull. 138*, 1896, pp. 18–19.

N. M. Fenneman: Physiographic Divisions of the United States, *Annals Assn. of Amer. Geogrs.*, Vol. 6, 1917, pp. 19–98; reference on p. 45.

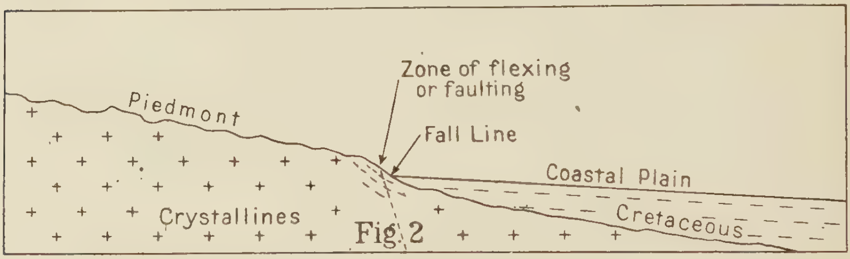
Cleveland Abbe, Jr.: A General Report on the Physiography of Maryland, *Maryland Weather Service*, Vol. 1, Baltimore, 1899, pp. 39–216.

[4] Joseph Barrell: The Piedmont Terraces of the Northern Appalachians, *Amer. Journ. of Sci.*, Ser. 4, Vol. 49, 1920, pp. 227–258; 327–362; 407–428; reference on p. 410.

[5] W. M. Davis: Physical Geography, Boston and London, 1898, p. 127. See also the figure on p. 128.

METHOD OF INVESTIGATION

The present investigation involved the construction of projected profiles across the Piedmont and Coastal Plain at right angles to the fall line[7] and the plotting on the profiles of the required geological data. This included the outcrops of the crystalline rocks and of the various members of the Coastal Plain series of sediments and the results of well borings in the Coastal Plain[8] to determine the slope of the crystalline basement. Many such composite projected profiles were made, ranging in location from Maine to Alabama, each covering a zone two miles wide. Miniature representations of six of the profiles (located as shown in Fig. 1) are herewith presented with vertical scale greatly exaggerated (Figs. 4 to 9). The profiles were compared and correlated with profiles and manuscripts kindly loaned the writer by



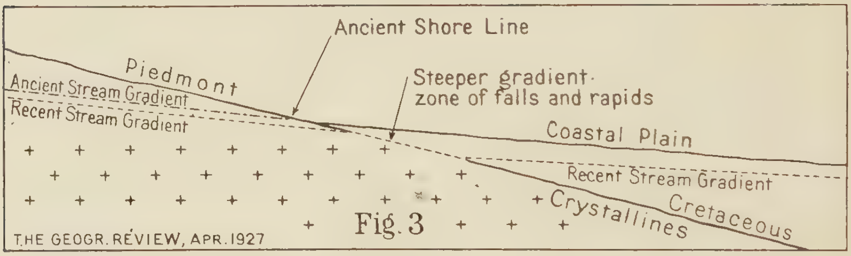


FIG. 2—Showing the interpretation of the fall line as due to faulting or monoclinal flexing.

FIG. 3—Showing the interpretation of the fall line as due to difference in the gradients which the streams have established on resistant and nonresistant rocks.

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[6] T. L. Watson: Mineral Resources of Virginia, Jamestown Exposition Commission, Lynchburg, Va., 1907, p. 3.

[7] These profiles were of the type developed by Johnson who simplified and improved the more complicated type used by Barrell. For a description of this type of profile see Douglas Johnson: The New England-Acadian Shoreline, New York, 1925, pp. 257–260, and Barrell, *op. cit.*, p. 242 (cf. p. 244).

[8] Darton, *op. cit.*, p. 162.

M. L. Fuller: Underground Waters of the Eastern United States, *U. S. Geol. Survey Water Supply Paper 114*, 1905, p. 158.

Idem: Geology of Fishers Island, New York, *Bull. Geol. Soc. of America*, Vol. 16, 1905, pp. 367–390.

L. W. Stephenson and J. O. Veatch: Underground Waters of the Coastal Plain of Georgia, *U. S. Geol. Survey Water Supply Paper 341*, 1915.

others interested in the problem.[9] They were also compared with profiles showing gradients of the chief streams which cross the Piedmont and Coastal Plain. By employing different vertical exaggerations of scale the different elements of the topography were studied to best advantage.

TABLE I—SLOPES COMPARED

PIEDMONT-NEW ENGLAND PENEPLANE	FEET PER MILE	CRYSTALLINE BASEMENT	FEET PER MILE
Georgia	2-5	Central Georgia	62
		Northeastern Georgia . . .	50
Virginia	5-7	Virginia	36
Maryland	7½	Maryland	50
New Jersey	8	New Jersey	42½
New Jersey-New York . . .	11	New Jersey-New York . . .	43
Western Connecticut	15½	Western Connecticut-Long Island	50
Eastern Connecticut	14½	Eastern Connecticut-Fisher's Island	85
Maine	18	Maine-Gulf of Maine . . .	45

ANALYSIS OF THE PROFILES

The profiles bring out especially well the peneplane character of the Piedmont upland and the New England upland. These uplands should probably be considered as two sections of the same peneplane (here dated tentatively as Tertiary). The slope of this Piedmont-New England Peneplane surface is shown by the figures in Table I. The greater slope of the peneplane north of New York is presumably due to greater tilting during uplift. The profiles, furthermore, bear out the statements made by Barrell and other writers, that the Piedmont-New England upland surface is not continued beneath the Cretaceous formation of the Coastal Plain. The slope of the Piedmont-New England upland surface usually averages from 5 to 15 feet per mile. The much greater slope of the crystalline basement below the Coastal Plain (see accompanying figures) makes the marked angle formed by the intersection of these two surfaces easily recognizable on the profiles even when a small vertical exaggeration is used. When records of scattered well drillings along a line in the Coastal Plain are plotted, they suggest that the crystalline basement is a fairly close approximation to a plane surface. Materials brought up in drilling from the sediments lying immediately on that surface have been interpreted as stream gravels of Cretaceous age.[10] Very probably the surface of the crystalline basement is a buried peneplane of pre-Cretaceous age. It is here dated tentatively as Jurassic. The slope of this buried and tilted Jurassic (?) peneplane emerges from beneath the Coastal Plain sediments and is continued upward along the face of the fall line belt of the Piedmont, being revealed through the recent stripping away of the Coastal Plain sediments by erosion. The amount of exposure of this basement peneplane slope is slight. It forms a zone about two and a half miles wide in Georgia, three miles in Virginia, four miles in Maryland, two (?) miles in New Jersey (all but two miles obscured by erosion and faulting in the Triassic weak rock lowland), four and a half miles in New Jersey-New York. This same more steeply sloping Jurassic (?) peneplane is exposed in southern New England through the removal of the once overlapping sediments to give the inner lowland of Long Island Sound. This inner lowland has been largely filled by glacial débris in the Cape Cod region, while in the Gulf of Maine it has been deeply submerged.[11] North of New York, the zone of exposure of the basement peneplane is 14 miles wide in western Connecticut, five miles in eastern Connecticut, 15 miles in the Gulf of Maine (nearly obscured by the erosion of infaulted beds of weak rock in the Triassic lowland of the floor of the Gulf). Evidence for the stripping of the Coastal Plain sediments from the seaward zone of the crystalline area is found in the remnants of sedimentary formations on the Piedmont in Virginia and on the New England upland in Massachusetts and elsewhere. The deflected courses of the lower Connecticut and many smaller streams strongly suggest that these courses were established when the sedimentary formations still overlapped the crystallines, at least as far inland as to the present fall line (Fig. 1).

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[9] In this way the author had access to profiles of the sea bottom in the Gulf of Maine, prepared by Harriet G. Bray, research assistant in physiography at Columbia University, and Martha Stolfus; profiles across southwestern Maine by Dorothy Houghton; profiles of southern New England by Martha Stolfus and C. H. Doane; profiles and accompanying manuscript covering the southern Piedmont by J. S. Brown. All of these profiles were prepared under the guidance of Douglas Johnson, professor of physiography at Columbia University. Other profiles and records prepared by various investigators were also consulted. In all, nearly a hundred projected profiles bearing on the nature of the fall line have been examined.

It has long been known that the slope of the Piedmont is not continued beneath the Coastal Plain; indeed, Davis himself has recognized this fact. But, what is more important, it has not been generally recognized that with the actual profiles of land surface and stream gradient which do exist, no falls could result from the conditions embodied in Davis's theory. If, as Davis suggests, the Piedmont rivers had established very gentle gradients leading to an ancient shore line near the present "fall line," the upland profile and the stream profile must have then intersected at that point (at *B* in Fig. 10). After the emergence of the Coastal Plain, the extended rivers must have rapidly entrenched themselves in the non-resistant Coastal

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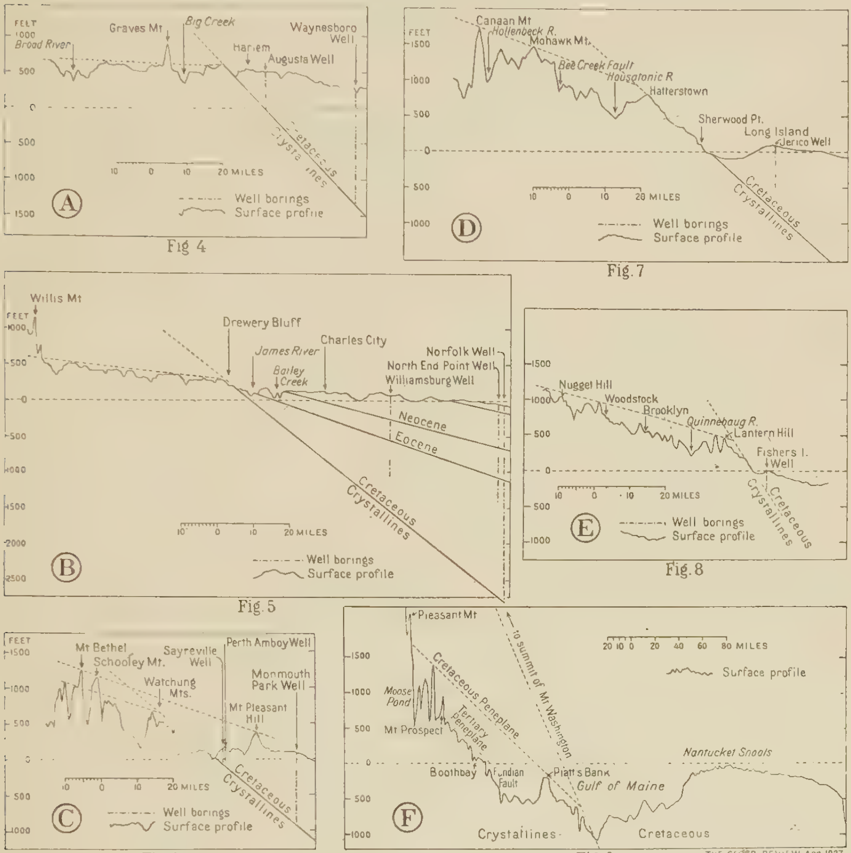
[10] Barrell, *op. cit.*, p. 408.

[11] Johnson, *op. cit.*, p. 300.

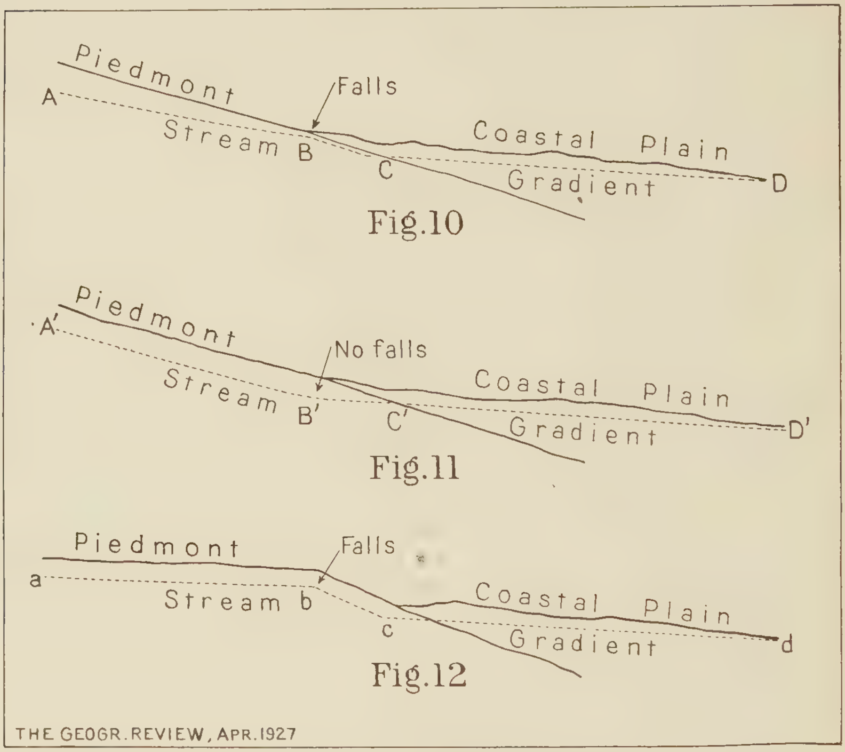
Plain sediments until they had established nearly level channels in their lower courses, whereas downcutting must have proceeded very slowly in the Piedmont. This would have resulted in a stream profile *A B C D* (see Fig. 10) in which the stream in the outer Piedmont



FIGS. 4–9—Profiles across the fall line. Profile A, FIG. 4, Georgia; Profile B, FIG. 5, Virginia; Profile C, FIG. 6, Northern New Jersey; Profile D, FIG. 7, Western Connecticut and Long Island; Profile E, FIG. 8, Eastern Connecticut and Fishers Island; Profile F, FIG. 9, Maine and the Gulf of Maine.

(at *B* in Fig. 10) would have been entrenched but little below the surface of the upland.

But actual profiles show that the streams are entrenched as far below the surface of the upland in the outer Piedmont (at *B* in Fig. 10) as in the portion farther westward (at *A* in Fig. 10). Indeed, a few streams appear to reverse the conditions which seem essential in Davis's theory, and are actually more deeply entrenched at *B* than at *A*. But if a stream has been able to entrench itself deeply at *B* it must, during the same time have entrenched itself at the same rate all the way from *B* to *C*. Hence there would have resulted merely a simple, concave stream profile from *A′* to *C′* (see Fig. 11) which would have given no falls or rapids. Nevertheless, the section *A B* of the stream does in fact possess a more gentle gradient than the section *B C*, and falls do exist where the change in gradient occurs. But the break in stream gradient is only incidentally related to unequal entrenchment in the hard rocks of the Piedmont and in the weak rocks of the Coastal Plain. Figure 12 shows that there is a marked break in the profile of the surface of the Piedmont itself, and it is at this point that the streams that are uniformly entrenched below the upland surface exhibit the break in their gradients. Thus Figure 12 embodies all the conditions necessary to produce a fall line zone and, in addition, harmonizes with known facts pertaining to the distance which the Piedmont streams have entrenched themselves below the upland surface. Moreover, Figure 12 has the added authenticity of being plotted directly from U. S. Geological Survey topographic maps.



FIGS. 10-12—Comparison of stream gradient and land profile:

FIG. 10—According to the theory advanced by Davis postulating an ancient shore line at B, and lesser stream entrenchment at B than at A.

FIG. 11—According to the theory advanced by Davis but modified by the fact that the streams are actually entrenched as deeply at B′ as at A′.

FIG. 12—According to data plotted from U. S. topographic maps.

THE ORIGIN OF THE FALL LINE

The fall line zone, therefore, lies along the outer edge of the crystalline area (Piedmont-New England Upland Province), where there is a break in the slope of the land due to the intersection of the recently exposed margin of the tilted Jurassic (?) peneplane with the Tertiary (?) peneplane of the uplands. As the gradients of the streams are closely related to the profile of the land, the break is sufficient to account for falls and rapids.

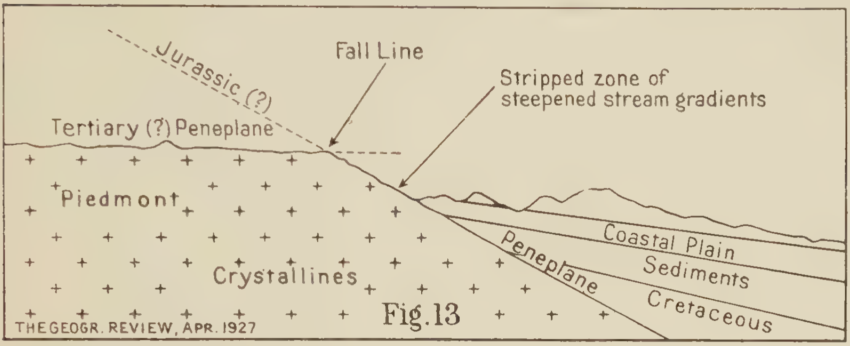


FIG. 13—Showing the interpretation of the fall line as due to the intersection of two peneplanes.

The fall line is thus genetically related to the physiographic feature described by Davis as a "morvan."[12] He applies this term to a peneplaned oldland which is submerged and buried beneath sedimentaries, then uplifted and tilted, and beveled by a second peneplane. A second uplift permits erosion to strip off the sedimentaries to form a weak-rock lowland faced by the tilted surface of the former buried peneplane. The profiles show this to be precisely the case at the fall line zone.[13] Here a "morvan" is formed by the intersection of the Jurassic (?) and Tertiary (?) peneplanes and a subsequent partial stripping of the tilted Jurassic peneplane by recent erosion. The difference in slope of the two peneplanes gives rise to a declivity or deflection in the course of nearly every stream that crosses the line of intersection of the two peneplanes. It follows that the Coastal Plain merely plays the rôle of providing the required mass of less resistant rocks above the older peneplane. There may be "fall lines" where no coastal plain exists. The angle of slope created by the intersection of a recent erosion level with an older more steeply tilted and once buried peneplane is all that is necessary to give a "fall line."

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[12] Named after the Morvan of central France: see W. M. Davis: The Relation of Geography to Geology, *Bull. Geol. Soc. of America*, Vol. 23, 1912, pp. 93–124; reference on p. 117, and *idem:* A Geographical Pilgrimage from Ireland to Italy, *Annals Assn. of Amer. Geogrs.*, Vol. 2, 1912, pp. 73–100; reference on p. 93.

[13] For block diagrams illustrating the development of this type of land form see Johnson, *op. cit.*, p. 28.

Perhaps future investigation will reveal other "fall lines" existing around the margins of the Adirondacks, along the Rocky Mountain front, at certain margins of the Triassic Lowland, on the margins of the Laurentian shield in Wisconsin, and in other places where similar conditions may occur. It seems possible that many falls now attributed to glaciation in the Adirondacks and elsewhere are really due to the presence of physiographic features of the "morvan" type, such as occurs along the eastern face of the Piedmont.

WORLD UNITY

George G. Chisholm

EPIGRAMS are not to be taken literally. The title adopted for this article is somewhat epigrammatic. It will be understood that I do not believe that the different parts of the world can ever be completely assimilated to one another. But there are intimate reactions between even remote parts of the world, with tendencies to more and more rapid response. Such reactions took place even in the distant past and, in some cases, between peoples who at the extreme limits of reaction knew nothing of each other. Such, for instance, seems to have been the case with the silk trade carried on in ancient times between China and the countries around the Mediterranean, when in China there was probably nothing known of the countries ultimately reached by the silks, and in these countries nothing of the country of origin. Probably, too, there was only comparatively little known of each other by the countries that carried on the much more important spice trade which had so great an influence down to the end of the fifteenth century on the fortunes of many great cities on the Mediterranean and between it and India.

But these reactions were small as compared with those of the present day. The trade in such articles, of small bulk although of great value for the time, was trifling in aggregate amount as compared with the trade of modern times; and indeed until modern times the trade of the world, except in such valuable articles, was for the most part limited to areas near the coast. Such heavy articles as foodstuffs could not bear the cost of transport for great distances by land, although sometimes they might be conveyed from the far interior by good navigable rivers. Hence it was that local famines occurred even in the countries of western Europe with astonishing frequency down to a comparatively recent date. In a paper read before the Statistical Society of London in 1846 the following statement is made as to England. "In the 11th and 12th centuries a famine is recorded every 14 years on an average, and the people suffered twenty years of famine in 200 years. In the 13th century, my list exhibits the same proportion of famines, and nearly the same number of years of famine; the addition of five years of high prices makes the proportion greater; upon the whole, the scarcities decrease during the three following centuries; but the average from 1201 to 1600 is the same,—namely, 7 famines, and 10 years of famine to a century."[1]

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[1] William Farr: The Influence of Scarcities and of the High Prices of Wheat on the Mortality of the People of England, *Journ. Statistical Soc.*, Vol. 9, 1846, pp. 158–174; reference on p. 163.

By way of contrast it is enough for us to think of the extraordinary fact that after four and a half years of the greatest war in history the inhabitants of the United Kingdom suffered no serious privation, being fed with grain and other food largely derived from remote parts of America.

TENDENCIES TOWARDS ECONOMIC EQUALIZATION

It was the introduction of railways that first made possible this extensive commerce in bulky commodities brought from and sent to places far from the seaboard, and the influence of railways has increased with the magnitude of commerce. The general tendency of this change has been to reduce the inequalities of economic development all over the world. An example is to be found in the growth of the world's railway network itself. Where railways are first introduced into a country requiring them, the increase in mileage year by year is at first rapid; but gradually there comes to be a time when such countries may be described as saturated with railways, and then there is a great slackening in the rate of increase, enabling other parts of the world to approach the first in the density of their network. A corollary from this is that old countries like Japan are being steadily brought under influences similar to those which began to affect Great Britain a hundred years ago or more, and it is interesting to see with what results. Between 1721 and 1846 the population of Japan was almost stationary. The great increase in population in that country dates from the abandonment of the feudal system and of the policy of exclusion in the sixties of last century; but it may be pointed out that the essential factor promoting this increase was the bringing of the Japanese seaboard into connection with other seaboards by the improved shipping of the present day and the introduction into Japan of modern means of connecting the interior with the seaboard, as well as the nearly simultaneous introduction of modern machinery. There is also a movement in the direction of a more equal distribution of population over the world. This tendency, it is true, is disguised by the fact that in some cases there has been a marked increase in the concentration of population in certain small areas; but in the broad view the general tendency holds. It is in new countries, and more particularly in their newer parts, that the rate of increase of population is found to be most rapid, the obvious cause being the extent of unoccupied and easily worked land.

Tendencies towards the equalization of capital and to a more varied and general development of the resources of all countries are noticeable. In Australia at first there was little but gold to attract the population; then wool became important. In Argentina and the Cape wool was for a long time predominant along with, in the former country, bones, hides, and dried meat; but now all these regions show a much more varied production. Also there is a tendency in the direction of greater uniformity of skill in different parts of the world. When modern machinery is introduced into countries previously unacquainted with it, output and quality are comparatively inferior; but in process of time both these defects come to be corrected, as will presently be shown.

Now, note that these changes do not come about of themselves without human intervention. They are the result of far-reaching forethought, but only to a limited degree. The great changes are mainly the accumulated result of a multitude of little changes more or less in the same direction, owing to the fact that vast multitudes are impelled by the same motive. To a very large extent that has been economic gain, a motive sometimes plainly, sometimes obscurely operative in bringing about such changes as have been due in the past to far-reaching schemes, mainly those for conquest.

Benefit to Humanity as a Whole

But of late there has been an increasingly marked disposition to consider whether it is not possible to devise institutions that will tend to the benefit of whole peoples and indeed, in consequence of the operation of the unifying tendencies to which attention has just been drawn, of humanity as a whole. For "capital and labour alike are coming to recognise that few of their deeper problems are any longer susceptible of merely national solutions. Markets, rates of interest, wages, and standards of living are more and more regulated by world-forces."[2]

We have, then, to ask what is for the advantage of humanity as a whole. I venture on a definition of human good which, I hope, will be adequate for practical purposes. Adhering to the view already expressed in my Herbertson Memorial lecture entitled "The Goal of Commerce,"[3] I say that the condition of humanity may be recognized as good when every human being enjoys the chance of a healthy and happy life.

It is, we have seen, the modern mechanical inventions that have been tending towards a greater and greater approximation to world unity and have thus in the end brought to birth the quest for the general good of humanity.

World Differences in Cost of Labor

With this underlying thought let us examine some of the obstacles in the way of economic unity. We may first consider the result of differences in labor conditions in different parts of the world, notably between East and West. That labor in the populous countries of the Far East is to be had at a relatively low cost is a fact that has long been familiar, so much so that we are apt to take it for granted that that difference between East and West must always exist. But if we are to satisfy ourselves as to that, we must ask the question as to how the cost of labor in those regions comes to be so low. If the tropical parts of the regions are considered, a common answer is that this is due to the extraordinary productiveness of the tropics. In some degree this may be accepted as true and, so far as it is true, this must be looked upon as a permanent advantage in favor of the tropics. There human labor is less required for the satisfaction of essential needs because the sun and rain do so much more for that satisfaction than in temperate climates. But it should be noted that this greater productiveness is not in food. The great staple foods, rice and other grains, give on the average rather smaller returns per acre in the tropics than the corresponding food plants of the temperate zones and a much smaller return per head.[4]

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[2] J. A. Hobson: Towards International Government, London, 1915, p. 196.

[3] G. G. Chisholm: The Goal of Commerce, *Geogr. Teacher*, Vol. 12, 1924, pp. 333–342; reference on p. 338.

Tropical Labor and Its Racial Heritage

Wages are also kept low in consequence of the inferior efficiency of the labor of tropical countries. But, unquestionable as this is, there is a great tendency to exaggerate the difference. So far as the inferiority is a fact it is due to various causes. Among these assuredly the racial heritage is one. Differences between races or other human groups are, however, difficult to establish with any clearness of meaning. One thing must be carefully noted. Inheritance can be affirmed only of the individual. If we speak of a group, large or small, as marked by hereditary characters, that means only that if we take the individual members of that group or a sufficient number of them to be representative, that group has a majority of individuals having those characters, even though it may include large numbers of others in which they are conspicuously lacking. Many striking examples might be given of the height to which individuals of different races can rise in different callings. But perhaps no illustration is better fitted to dispel prejudices as to race inequalities than that given by J. H. Oldham in his "Christianity and the Race Problem,"[5] from Trinity College, Kandy, Ceylon, "one of the most notable educational institutions in the East," a college including "a great variety of races—Singhalese and Tamils, Burghers,[6] Eurasians and pure Europeans from Ceylon, various races from India, Burmese, and a few Africans from Uganda"; and as to these he tells us that the principal of the College "is convinced in the light of his experience that, while the different races show special aptitudes in particular directions, in the general all-round capacity which makes a boy fit to be a prefect or captain of the school it is impossible to discriminate between the races. No one can foretell a few years ahead which race will in a given year in proportion to its numbers be most strongly represented in the leading positions in the school." Not all anthropologists concur in the assumption that there is any inherent superiority in the white race.

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[4] The fairest comparison under this head is between rice and wheat. According to the *Imperial Gazetteer of India*, Vol. 3, p. 29, the average yield of a transplanted crop of rice in good soil is 2400 pounds of paddy, say 1440 pounds of clean rice per acre. The average wheat yield of New Zealand in the ten years 1900–1901 to 1909–1910 was equal to about 1900 pounds per acre. See the author's "Handbook of Commercial Geography," 9th (or 10th) edit., London, 1922, p. 37.

[5] J. H. Oldham: Christianity and the Race Problem, New York, 1924, pp. 35 and 83.

In any case we must never forget that there are causes other than the qualities due to descent that contribute to the differences in productiveness of different races or peoples as they are at the present day. In tropical regions disease and climate are specially important under this head. "He who tries to form an estimate of the quality of manhood of the Dravidian from personal observation," says Professor Slater, "should allow for the fact that the great majority of those with whom he comes in contact are sick men, suffering from diseases till recently very little understood, but, when understood, preventable."[7]

Tropical Climate and Diseases

The principal diseases here referred to are malaria and hookworm disease, as to the prevalence of which in India, for example, and their effects in diminishing productiveness striking testimony is borne by the Report of the Indian Industrial Commission.[8] In the Madras Presidency nearly the entire population was reported to be infected with hookworm disease, and even in the tea gardens of Darjeeling over 70 per cent of the laborers were infected. How serious is its effect on output is shown by the fact that treatment of the disease by vermifuges led to a 25 per cent increase of output. As to malaria the Report states that the financial cost of dealing with it is dreaded, the financial return not appreciated. And it asks "Is it not an irony that the most important research of which the results were applied with such profit in Panama was research work done in India, work which has done so little for India yet?"[9]

On climate it is not needful to say much. Some interesting hints on this head are given by Dr. Albert Schweitzer in his work "On the

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[6] People of mixed race, partly Dutch descent, resulting from the Dutch occupation of the island (1658 to 1796).

[7] Gilbert Slater: The Dravidian Element in Indian Culture, London, 1924, p. 179. Reviewed in the *Geogr. Rev.*, Vol. 16, 1926, pp. 680–681.

[8] British Blue Book, Cmd. 51, Parl. Papers, Vol. 17, 1919, pp. 459–462.

[9] *Ibid.*, p. 462.

Edge of the Primeval Forest."[10] He refers, for example, to the ease of treating heart disease, for the patients quite readily obey orders to rest for weeks at a time. The surprising thing rather is the capacity of natives of even the hottest and moistest parts of the tropics for hard work on special occasions. The effects of such a climate in adding to the work to be done through the vigor of the vegetation are also well known. "We live," says Dr. Schweitzer, "between the river and the virgin forest, on three hills, which every year have to be secured afresh against the invasion of wild Nature, who is ever trying to get her own back again."[11]

TABLE I—LETTER SORTING IN POST OFFICES IN DIFFERENT PARTS OF THE WORLD

PLACE	AVERAGE NUMBER SORTED PER HOUR	AVERAGE WAGE PER HOUR—CENTS	AVERAGE WAGE PER 1000 SORTED—CENTS
London	1800*	40.	22.25
Provinces, Great Britain	1800	32.5	18.1
Calcutta	720†	14.	18.5
Tokyo	570‡	7.8§	12.7§
Shanghai	2000	6.0	3.0

*Primary sorting into 30 or 40 general divisions.

†The maximum number required from each sorter.

‡Including assortment, examination, calculation of numbers, stamping, sorting, making up bundles, making up mail bags, weighing mail bags, and reviewing bills and tags.

§The yen taken at 51 cents.

AN EXAMPLE OF PRODUCTIVENESS OF TROPICAL LABOR

It is further to be noted that, great as the differences may be in the productiveness of different peoples as they are now, one is sure to be misled when it is tacitly assumed that their extent is measured by the differences in the wages paid. This assumption, often expressly taken for granted, is assuredly false. But fair comparisons under this head are not easy to arrive at.

Not long ago it occurred to me that one method of ascertaining the productiveness of labor employed under the same or at least similar conditions in different countries would be to inquire as to the average number of letters sorted per hour in post offices and the hourly wage for the work done. I give in Table I the results of the answers to my inquiries. From these it will be seen that even in this simple case it is difficult to get information applicable to exactly the same conditions of work. The facts given, however, are instructive and absolutely disprove the contention that wages in different countries are proportioned to efficiency.

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[10] Albert Schweitzer: On the Edge of the Primeval Forest, London, 1922, p. 45.

[11] *Ibid.*, p. 39.

INDUSTRIAL COMPETITION OF THE ORIENT

I have repeatedly drawn attention to the steady gain of the machine industries of the Orient in competition with the corresponding industries of the West and to the fact that this competition is steadily though slowly growing in effectiveness and coming to apply to higher and higher branches of industry.[12]

Business men are now becoming more widely convinced that this gain on the part of rivals is in progress and that it is to be ascribed at least in part to the low price of the competing labor, that is, low in proportion to efficiency. "I am satisfied," says a correspondent of the *Manchester Guardian Commercial*, "that the seven thousand million yards [of exported bleached cotton goods of 1913] are not likely to be ours again. Millions of those yards were the low-priced bread-and-butter goods which Lancashire will never make again. As much as the world requires of such cloth will be made by the native industries . . . with all the advantage of cheap labour and so forth." However, he feels confident "that the trade in the finer goods is still ours without much effort."[13]

Without doubt there is much in the brief history of British manufacturing and commercial development that seems to justify this cheerful frame of mind. But we should not leave out of account the special circumstances that have for a time made that compensation ample. For a short period, say a century and a half, the world has been spreading and multiplying its population over new lands at an unparalleled rate; and, concurrently, in the greater part of those areas the production of the prime necessaries of human existence has been increasing at an even greater rate. There has been a hitherto unexampled growth in the magnitude of world commerce, a growth quite adequate to enable Great Britain to make up for many losses absolute or relative occurring here and there.

But must this go on indefinitely? Does nothing hint that progress based on such conditions may and indeed must come to an end? Have we even good ground for believing that "the trade in finer goods" will long remain "ours without much effort"? Confidence in this respect ought to be somewhat sobered by remembering that in some classes of goods, such as the manufacture of dyes and dyestuffs, Great Britain soon lost, if she ever had, that preëminence.

In the textile industry it is sometimes contended that the lack of skilled labor makes it impossible to introduce into the lands of the Orient, where so much of the competition with Lancashire industries takes place, the elaborate and expensive machinery required for the finer products. But this need not be a permanent state of affairs.

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[12] See the author's "Handbook of Commercial Geography," 9th (or 10th) edit., pp. 172–173.

[13] *Manchester Guardian Commercial, Supplement on "The Textile Finishing Trades,"* July 2, 1925, p. 9.

In itself it is no proof of inherent difference in capacity between Oriental and Occidental labor. In the Orient there is neither the opportunity nor the inducement to supply the education needed for skilled labor. And as to capacity consider what is stated by Professor Slater in writing of a visit he paid to the great iron and steel works of the Tata firm at Jamshedpur. There, he says, he found natives "who became adepts at the highly skilled task of straightening steel rails, who were willing to accept 11 d. a day for a much larger output than the Yorkshiremen who were first employed."[14] Or consider this perhaps more surprising instance. A correspondent writing in the *Times* and reporting the high opinion formed by the manager of the Hanyang iron and steel works (China) of the mechanical ability of the Chinese, gave on his authority the following instance. "All the parts of a locomotive had come from America, but nothing was to be done about assembling it until the drawings came, which for some cause were delayed. He [the general manager] forgot to mention this to the shop foreman, a Chinese. Shortly after its arrival he was surprised to see the engine running up and down the tracks, being tried. They had assembled it without the drawings and had done it right."[15] The manager said he would never have attempted it himself without the drawings. This only confirms an opinion which Baron Richthofen had expressed more than thirty years before, on the strength of which he foresaw foreign capitalists coming to China to utilize the extraordinary resources of that country both in material and labor. "It is to be expected," he adds, "that the inhabitants themselves will seldom take the initiative";[16] but this we are now getting more and more reason to doubt. C. A. Middleton Smith in his book "The British in China"[17] recognizes the general lack of success of great enterprises in China under purely Chinese management but points out that this is not true outside of China.

ORIENTAL STANDARD OF LIVING AND OVERPOPULATION

But, however great the capacity of Oriental races may be, the enormous difficulty of raising the efficiency of the bulk of the people is recognized by all who are acquainted with those countries. It involves a great rise in the standard of living. All the great countries of the Orient are alike in having an agricultural population much in excess of that required for the greatest production per head. All are alike in meeting the increase of that population by subdividing the land among the children, with the result that the holdings become smaller and smaller so that really economic cultivation becomes impossible. Where this has been going on for a long period the majority are thus compelled to content themselves with a product sufficient merely to keep them alive in fairly good years without the possibility of accumulating capital that would enable them to improve their cultivation.[18]

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[14] Gilbert Slater: The Steel Industry of India, *Economica*, Vol. 5, 1925, pp. 62–68; reference on p. 64.

[15] *London Times Engineering Suppl.*, Feb. 17, 1909, p. 18, col. 2.

[16] Ferdinand von Richthofen: China (6 vols., Berlin, 1877–1912), Vol. 2, p. 694.

[17] C. A. Middleton Smith: The British in China, London, 1920. See pp. 44–45, 108–110, and 158.

In this, as it seems to me, is to be found the explanation of the small purchasing power of Far Eastern countries and the low-wage competition which they carry on with the more advanced industrial countries of the West.

Where there is a large agricultural population thus living on the very margin of subsistence I am unable to see how they can be prevented from offering their labor to manufacturers at money rates of a scale of living little, if any, above what they might get in their own villages when they can get anything at all there. The result is prejudicial both to agriculture and to manufacturing. Town life with low wages is so repellent to the peasants of tropical countries that those who go to towns to work can with difficulty be induced to stay long enough to acquire industrial skill. There is a constant drift from the country to the towns and from the towns back to the villages.

As to the condition of the villages the testimony of the Aga Khan is striking. "I could safely challenge," he says, "any widely travelled and observant fellow-countryman, familiar with social economics on each of the great continents, to deny after due reflection that the present condition of Indian agriculture and of the 219,000,000 human beings dependent thereon is the greatest and most depressing economic tragedy known to him."[19]

It has already been recognized that with the aid of capital and skill agriculture may be made to yield more per head. But a limit to such improvement is soon reached. Agriculture speedily passes from the state of what is technically called increasing returns to one of diminishing returns. This is now so universally known that it does not need to be stressed. But I venture once more to insist,[20] in defiance of the prevailing teaching of economists, that it is the diminishing returns in agriculture, especially if we use that term in the wide sense in which it is used by Italian statisticians so as to include also the working of minerals, that are the root cause of diminishing returns in other industries. I am not disposed to quarrel with the assertion of the Right Honorable Reginald McKenna that "in manufacture there is no law of diminishing returns," manufacture being regarded apart from the sources of raw material.[21]

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[18] See the recent statement of the problem for China by W. H. Mallory: "China: Land of Famine," *Amer. Geogr. Soc. Special Publ. No. 6*, 1926.

[19] Aga Khan: India in Transition, Bombay and Calcutta, 1918, p. 201.

[20] See pp. 337–338 of "The Goal of Commerce," *Geogr. Teacher*, Vol. 12, 1924.

[21] Speech delivered at the general meeting of the Midland Bank, London, January 26, 1926.

In the most densely populated areas of India and the other countries of the Far East where the great bulk of the population are engaged in agriculture there is no hesitation on the part of anybody in speaking of overpopulation, and very few question the opinion that the extreme wretchedness of the population is to be largely ascribed to that as a cause.

Overpopulation in the West

It is more difficult to prove that highly developed countries dependent largely or mainly on manufactures, commerce, and the investment and management of capital can be spoken of at any time as overpopulated, but it is at least certain that all of these, in virtue of the very conditions under which their varied industries are carried on, are locally overpopulated with reference to the housing accommodation and even the adequate supply of good food and other requirements of such healthy existence as is necessary even for the greatest possible economic production. How terribly true this is any one will vividly realize who will read the earnest and honest little book by C. P. Blacker, "Birth Control and the State."[22] It is such overcrowding as is there described (see especially p. 46) that the reactions of our trade with overpopulated countries elsewhere tend to perpetuate.

So far this struggle has at least been eased, as has been already noted, by the existence of vast tracts of unused land where there is no need to force production to the utmost, where comparatively little labor gives an ample return at least in necessaries, supporting a large surplus of labor to supply conveniences and luxuries. But for how long will this relief last? Dr. O. E. Baker in "Land Utilization in the United States: Geographical Aspects of the Problem" is of opinion that the United States reached the height of agricultural land supply relatively to population about 1890 and that the people of that country have entered a period which will necessarily be marked by a continually increasing scarcity of land.[23] Professors E. M. East and Warren S. Thompson maintain that when the cost of agricultural implements is included the United States reached the stage of diminishing returns between 1890 and 1900.[24] Professor East is further of the opinion that Argentina may indeed have still forty-five years for increasing returns in agriculture but that after 1964 at the latest, overpopulated countries will, as he puts it, "cease to be boarded by oversea hotels unless current effective causes change."[25] Again

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[22] C. P. Blacker: Birth Control and the State, London, 1926.

[23] O. E. Baker: Land Utilization in the United States: Geographical Aspects of the Problem, *Geogr. Rev.*, Vol. 13, 1923, pp. 1–26. See also "The Utilization of our Lands for Crops, Pasture and Forests," *Yearbook Dept. of Agric. for 1923* (pp. 415–506), p. 442.

[24] E. M. East: Mankind at the Crossroads, New York and London, 1923, pp. 152, 173, and 177.

[25] *Ibid.*, p. 88.

Dr. Baker in a paper on "The Potential Supply of Wheat"[26] gives the white man a century of grace in which to consider this path on which he is moving and to profit by such lessons as he can draw. Of course there will be nothing sudden in the destined change. The year 1964, we may be sure, will not be very different from the year 1963. That unquestionably is all the better for him.

Population Control

The remedy most generally offered by those who have the courage and insight to face the problem as it is goes no further than to recommend the control of population without stating how it is to be brought about.[27] True, some of those cited consider without censure the use of contraceptives as a means of birth control,[28] and it is of no little significance that Sir William Beveridge has at last come to regard this practice not merely as a menace.[29] All that I have read and thought on this subject leaves me in no mind to question the contention of Sir William Beveridge as to the degree of importance to be assigned to what he describes as this "underground invention," an importance hardly less, he thinks, than any others except the greatest of all such as fire and speech, and which, he believes bears for mankind "many possibilities, good or evil." But there remains the task of applying it for good.

In connection with this problem of population control I venture with great diffidence on a suggestion which I can only hope may be thought worthy of consideration by those who are much better equipped than I am to deal with the enormous difficulties it raises. There is no space here to discuss even the difficulties that I foresee: it must suffice to offer the suggestion.

Coöperation Between all Industries

Within the last half century distributive, agricultural, banking, and other coöperative societies have achieved wonderful success with little outside direction, but through a process of growth—which is quite natural when each member of the society is conscious of finding his own advantage in the advantage of all. Such societies have proved remarkably suited to the soil of India.[30] Much more wonderful results might, I think, flow from a well devised scheme of direct coöperation between agriculture and manufacturing and indeed all other forms of industry; and nowhere, it seems to me, are these results likely to be more salutary or in some respects more easily achieved than in India. If the large surplus of agricultural labor is in the future merely to be drawn into manufactures by the demand of capitalists, whether Indians or not, the result is merely to introduce another competitor on the world markets and go on making things worse and worse. But it might be otherwise if it were possible to organize a sufficiently large group of agriculturists and manufacturers to supply material wants first of all on coöperative principles.

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[26] O. E. Baker: The Potential Supply of Wheat, *Econ. Geogr.*, Vol. 1, 1925, pp. 15–52.

[27] T. N. Carver: Essays in Social Justice, Cambridge, Mass., 1915, pp. 50–51.
A. M. Carr-Saunders: The Population Problem, Oxford, 1922, pp. 314 and 316.
Baker, Potential Supply of Wheat, pp. 51–52.
E. F. Rathbone: The Disinherited Family, London, 1924, pp. 247–248.

[28] Carr-Saunders, *op. cit.*, p. 315.
Rathbone, *op. cit.*, p. 244.

[29] Sir William Beveridge: The Fall of Fertility among European Races, *Economica*, Vol. 5, 1925, pp. 10–27; reference on p. 21.

[30] A very striking example is given in British Blue Book, Cmd. 950, Parl. Papers, Vol. 34, 1920.

A primary requirement would be to ascertain for each district the size of holding most favorable to maximum production per head regardless of production per acre where a higher production on this latter standard can be obtained only at the cost of a smaller production per head. An equally indispensable requirement would be to get the agricultural population to understand that the holdings must on no account be diminished unless the conditions of maximum production changed and that their numbers must therefore be regulated according to their holdings, which would probably involve the necessity of teaching them the methods of birth control. But it would be necessary not to confine the benefits or the restrictions to the agriculturists. These must be shared by all alike.

For members of such an association to be dependent on themselves alone for the satisfaction of all their economic demands would be hostile to progress. Only necessaries would be regarded as perforce produced within the organization, but if we are to keep in view our definition of human good a large meaning would have to be given to the term necessaries. It would include, besides of course ample supplies of good food, ample dwellings, ample room round the dwellings, adequate insurance, including provision against the variation of agricultural yield from year to year, whether due to climate or cropping, as ascertained by local experience, sufficient education to enable them to follow the best methods of production and to understand the necessity and learn the means of limiting their numbers. Further education might be left to take care of itself. A community like this, having leisure for amusement, would find much of that amusement in following the arts and would learn by mutual aid and stimulus, and the interest of acquiring knowledge would attract a certain proportion of the population and would spread through the enthusiasm of those who gladly learn and gladly teach. The likelihood, it seems to me, is that in such a community learning would advance more rapidly than in the countries best endowed educationally at the present day, in which it is common though not generally avowed knowledge that the higher education is mainly warfare, competition carried to extreme by the struggle for existence or the striving for what Mr. Hawtrey calls "false ends."[31]

I do not for a moment forget the difficulty of procuring either in India or any of the other countries of the Far East even momentary consideration for a proposal which runs so directly counter to the age-long tradition requiring sons to marry early as a religious duty to their parents; but, once this initial difficulty were overcome and the experiment actually made, human nature might be counted on to bring about a change of feeling through experience of the relief afforded. If a single experiment of this kind proved successful, say in India, there can be little doubt that the example would come to be followed in other parts of the Far East where similar conditions are to be found.

The Problem in the Industrial West

It would probably be much more difficult to bring about a more equable distribution between agriculture and manufactures in the other parts of the world and most of all in such excessively crowded areas as we have in the northwest of Europe and some parts of the northeast of the United States where there has been a lamentably one-sided development of manufacturing industry. Still, if the beneficial results of a more intimate connection between agriculture and manufactures were once made so clear that none could fail to see them, efforts would surely be made to overcome all the difficulties in the way of achieving those results and would be stimulated by the ever-increasing urgency of the felt evils of present conditions.

Professor Warren J. Thompson of the Scripps Foundation for Research in Population Problems, Miami University, Oxford, Ohio, apparently looks on the destiny of Great Britain as hopeless and contents himself with warnings to other countries. "Things," he writes,[32] "are moving faster now than in the days when Britain gained her industrial supremacy, and if the United States or Germany or Japan should attempt to follow in Britain's steps, devoting itself almost exclusively to the development of factory industry and world trade, and neglecting its agriculture, that country will soon rue the day when it followed after false gods." The people of Great Britain can only hope, let us trust courageously and resolutely, to find a way of escape from the fate that appears to threaten them, but I do not see how that is to be brought about merely by attending to agriculture. It must, I think, involve the endeavor to maintain a due balance between agriculture and other industries.

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[31] R. G. Hawtrey: The Economic Problem, London, 1926.

[32] Warren S. Thompson: Britain's Population Problem as Seen by an American, *Econ. Journ.*, Vol. 36, 1926, pp. 177–191; reference on p. 190. Noted in the *Geogr. Rev.*, Vol. 17, 1927, pp. 152–153.

CONCLUSION

Let us now in conclusion look back. Our subject is World Unity. What, it may be asked, is the bearing of what I have suggested on this subject? I will try to answer that question mainly by quotations from two persons of very different standing, but both, it seems to me, worthy of attention. The first quotations are from a letter signed James Quinton, published in the *Manchester Guardian Commercial Supplement*, September 17, 1925. "There was a time," he says "when, as a maritime labourer, I sailed before the mast. As the result of a long period on the Australian coast I know the conditions which prompt the systematic movement of marine workers there. . . . It has long been a cardinal principle enunciated by Australian unionism that a worker's social standard embodied in a new protection policy could not be permanently maintained in face of opposition from world economic laws. This fact borne in mind has invested Australian labour with a desire to assist all external efforts to raise labour conditions to the level of Australian. . . . Such an international unity of interests would undoubtedly be a potent instrument to remove all causes of international misunderstanding."

These are essentially the ideas expressed in the introductory paragraph to Part XIII of the Treaty of Versailles on which is based the International Labour Organization. I have given reasons for believing that such aims can be accomplished only by slow stages, but, if that is so, I am glad to find that I am at one with a highly distinguished man of science in thinking that the slowness of social change is not necessarily to be regretted.

In an article on "The First Physical Synthesis" in a composite volume in the Unity Series edited by F. S. Marvin, A. N. Whitehead, Professor of Applied Mathematics in the Royal College of Science, London, after contending that without Galileo and Newton western history would have been quite different, goes on to say—"The Fates do not always offer the same gifts twice, and it is possible that the eighteenth century might then have prepared for the western races an intellectual sleep of a thousand years, prosperous with the quiet slow exploitation of the American continent, as manual labour slowly subdued its rivers, its forests, and its prairies. I am not concerned to deny that the result might have been happier, for the chariot of Phoebus is a dangerous vehicle."[33]

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[33] Science and Civilization, The Unity Series, No. 6, pp. 162–163.

THE MILLIONTH MAP OF HISPANIC AMERICA

Raye R. Platt

IN 1920 the American Geographical Society announced the organization of a Department of Hispanic American Research, for the purpose of carrying out an intensive program of geographical studies in Hispanic America. In 1922, with the publication of Mr. Alan G. Ogilvie's "Geography of the Central Andes" and the La Paz sheet of the Map of Hispanic America on the Millionth Scale, the first results of this program were made public. In 1925 two more sheets were published. Seventeen more sheets have now been completed, bringing the number of published sheets to twenty out of a total of one hundred.

The published sheets represent only a small part of the work which has actually been done. In them has been incorporated but a fraction of the source material which has been assembled in the past six years. It is to the gathering of such material and its study that the resources and personnel of the Department have been chiefly devoted since its organization.

To secure all of the available source material and to analyze it intelligently required that compilation on a large number of sheets be carried on simultaneously. Thus it has resulted that, in addition to the twenty sheets now published, thirty-six others are in various stages of compilation, fair drawing, and proof. When completed, these sheets will cover all of the west coast and Caribbean republics, the West Indies, and considerable territory in the Amazon Basin. They will cover sections of Hispanic America that are of the greatest interest to the physiographer and the geologist and, by virtue of their physiographical and geological make-up, of scarcely less interest to the meteorologist, the biologist, and the student of political and economic geography.

NEED OF A NEW MAP OF HISPANIC AMERICA

To provide a cartographic base, as a preliminary to undertaking comprehensive geographical studies in Hispanic America, the work of the department has been focused upon the Millionth Map. The demand for information on Hispanic America, scientific and economic, increases daily. The Society is constantly besieged for good maps of one section or another of Central and South America, and similar institutions elsewhere probably have like experience. The answer must of necessity be that there are no good maps: no maps which will at all adequately serve the needs of intensive field work: no maps for the accurate plotting of the distributions in which the geographer, the botanist, and the economist are interested.

DIFFICULTIES IN ASSEMBLING SOURCE MATERIAL

There are in the United States and in Europe, in the files of geographical and geological journals, and in collections of sheet maps, extensive surveys of parts of Hispanic America. There are, however, few careful compilations of these surveys into general maps covering any considerable extent of territory. There is no general catalogue of the contents of a group of such collections; nor is there for the individual collections any analysis of the relative merits of their parts. Not only is the student balked at the very first by not knowing where to look for surveys in the region in which he is interested, but, once finding access to a given collection, he is "frustrated by its paucity, or its unordered state, or the highly unequal qualities of its parts."

Particularly difficult does he find the grading of published maps to which fine engraving and coloring may lend an air of importance quite out of keeping with the merits of the original map. A case in point is Sievers' surveys in Ecuador and Peru published in *Petermanns Geographische Mitteilungen* (Vol. 61, 1915). We had considered these maps of great importance not only as to accuracy of detail within themselves but also for tying in other less accurate material. However, when the compilation of the Quito, Piura, and Cerro de Pasco sheets, on which these surveys fall, was undertaken, it was found that neither in detail nor in location did Sievers' maps correspond with other surveys of unquestionable merit which coincided with them at various points. On further study it was discovered that Sievers had used the Raimondi Map of Peru as a base and had only roughly filled in details along his route.

Map titles are frequently misleading. Again and again our compilers have come upon a map accompanying an article on exploration entitled "Author's Sketch Map" only to find that the map is merely a copy of some earlier general map upon which the author has drawn a line to represent his route.

To the student who undertakes the study of any phase of Hispanic American geography the problem is almost impossible of solution. He ought not to be obliged to preface his studies with a prolonged examination of cartographic sources and with map compilation for which he may have neither the time nor the technical training. He ought to be provided with maps on a scale sufficiently large for his needs, in which he is assured that the best surveys available have been critically incorporated and on which he can readily distinguish between surveyed and unsurveyed areas.

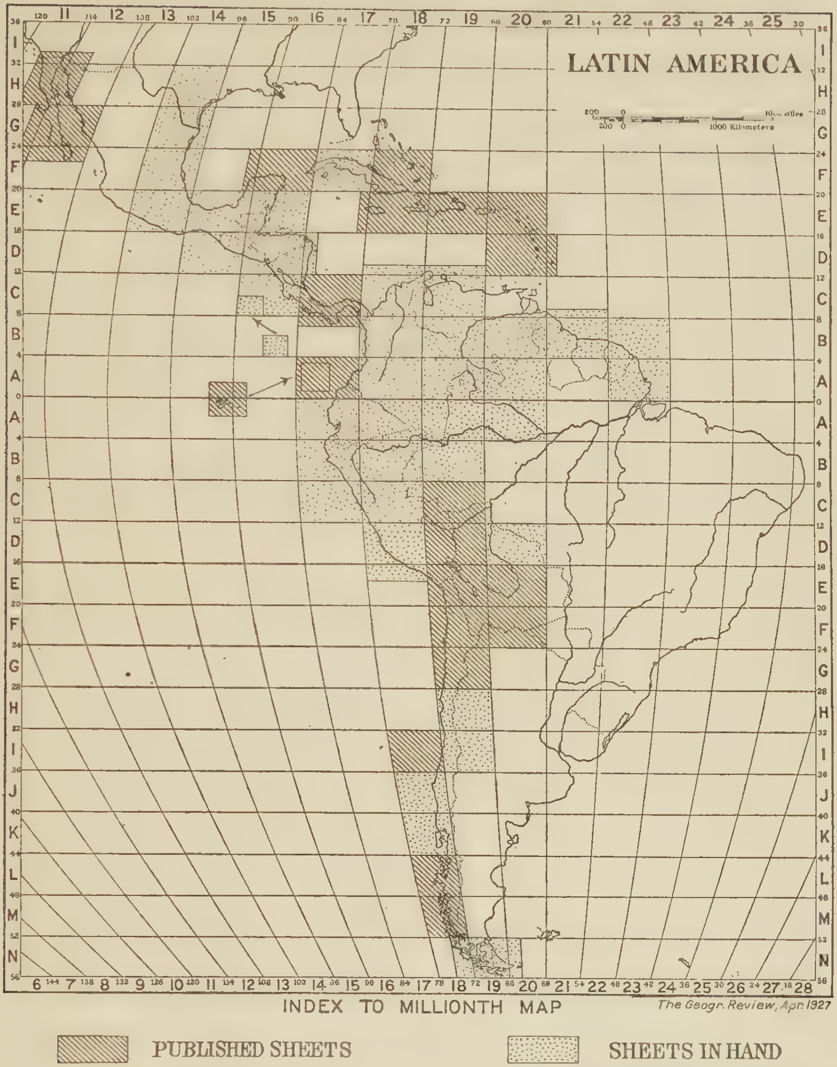


Fig. 1—Index to the American Geographical Society's Millionth Map of Hispanic America. The published sheets are: North H-11, Baja California Norte; North G-12, Baja California Sur; North F-16, Yucatán; North F-18, Santiago de Cuba; North E-18, Kingston—Port-au-Prince; North E-19, Santo Domingo—San Juan; North E-20, Lesser Antilles North; North D-20, Lesser Antilles South; C-17, Panamá; North A-17, Río Mira—Islas Galápagos; South C-19, Acre; South D-19, Puno—Río Beni; E-19, La Paz; E-20, Sucre; F-19, Iquique; F-20, Río Pilcomayo; G-19, Atacama; I-18, Cauquenes y Islas Esporádicas; L-18, Península de Tai-Tao; M-18, Isla Wellington—Lago Argentino.

Failure of Existing Maps to Use Available Sources

In general, published maps of the various Hispanic American republics or of Central or South America as a whole have made only partial and often inaccurate use even of those surveys which are easily available. For instance, there is no general map, whether of individual countries or of the larger geographical divisions, that has made accurate use of the surveys made during the last decade of the nineteenth century by the Intercontinental Railway Commission. Most maps completely ignore this survey, in spite of the fact that it extends with but few gaps from the Mexico-Guatemala boundary to central Bolivia and has in large part proved to be accurate.

Undoubtedly the assembling of even such additional surveys as may not have had any general distribution, although accessible to the public in a limited number of collections, would be too costly to be undertaken for a map which must sell at a profit. However, even if the map publisher could assemble all the surveys contained in these two classes, there would still remain two important classes of map collections which may well be termed inaccessible to the commercial cartographer—unpublished maps in the various archives of the Hispanic American governments themselves and the surveys made by foreign interests for the study and commercial development of areas having potential natural resources.

Surveys Made by the Hispanic American Governments

In the former class are studies for railways, roads, and trails; surveys for port development, irrigation projects, and water supply; practice reconnaissances by the topographic sections of military schools; and the material which may be accumulating for years between the date when the surveys are undertaken for any particular sheet of the systematic topographic surveys on which several of the Hispanic American governments are engaged and the date when the surveys are completed and the sheet published. Even to a geographical institution which has long maintained exchange relations with many of the bureaus of the Hispanic American governments very little of this unpublished material is easily available. The task of sorting such an accumulation of documents is too great to be requested of the staffs of the various bureaus themselves, however interested they may be, and too burdensome to be imposed upon diplomatic or consular officers.

In 1924 and 1925, therefore, the writer spent eight months in South America for the purpose of explaining the Society's program of Hispanic American research to the various governments and obtaining permission to examine the unpublished surveys in the departmental archives. Seven South American governments were visited. A résumé of the immediate results was given in the Annual Report of the Society for 1925. Quite as important was the making of friends for the map, who are a constant source of new material and of information useful in future work. No difficulty was experienced in convincing government officials visited of the disinterested character of the project. The scope of the map and the program of research to be based upon it were sufficient evidence of that. The value to these governments of a map which will give as accurate an expression of the topography and political geography of their own and neighboring countries as present knowledge will permit needed no argument.

Surveys Made by Foreign Development Companies

Since the World War the surveys made in Hispanic America by American and European development and construction companies have far exceeded the total of those made by scientific explorers and by the governments themselves. By virtue of their origin these surveys are in large part confidential. They represent heavy investments in fields where competition is great. Yet they outrank all other classes of compilation material, because in general they lie beyond the present frontiers of settlement. Here again the scope of the map and the program to be based upon it have been our chief ally.

Development companies interested in Hispanic America recognize their need of maps as a basis for exploration. They need general maps which will give topographic expression to the best physiographic knowledge available. They need maps which will supply the most reliable information on political boundaries, location and population of towns, navigability of rivers, accessibility of railroads, status of roads and trails. They further need to know wherein these details are based on actual surveys and what are the relative merits of the surveys. In brief, they need such a map as the millionth sheets supply because the map itself embodies a large part of the essential studies preliminary to a detailed examination of any particular area. To the furtherance of such a map they are willing to contribute even their most confidential surveys once they are assured of the integrity of the compilers in handling confidential material. Without exception both American and European development and construction companies have responded whole-heartedly when the scheme of the map has been presented to them.

Adoption of the Scheme of the International Map

When in 1920, the Society adopted the standards of the International Map of the World on the Scale of 1:1,000,000 for a new map of Hispanic America, much doubt was expressed as to whether there was available enough source material of sufficiently high quality to justify the adoption of either the standards or the scale of the International Map. To the latter objection we replied that if the map was worth doing at all it was worth doing on a scale sufficiently large for actual use in the field. The millionth scale, which expresses one kilometer on the surface of the earth by one millimeter on the map, is large enough for that purpose; but no smaller scale will serve.

The standards of the International Map were adopted because they achieve the purposes which the map is designed to serve. Briefly those purposes are: to use the source material available to all cartographers with greater accuracy and discrimination than has been employed on previously compiled maps; to add to these sources the great mass of material in the archives of government bureaus and the collections of development and construction companies which is not available to the commercial cartographer; to give, by means of contours and layer tints, topographic expression to our best knowledge of the physiography of both the land areas and the sea floor; to present the cartographic details obtained from the sources used so as to distinguish between surveyed and unsurveyed areas; to express the most accurate information available as to location and status of political boundaries, position and population of towns, location and gauge of railways, location and character of roads, location of telegraph lines and stations; in a word, to furnish a map which will represent, as far as the conventions of the topographic-political map will permit, the results of a critical and exhaustive research into the cartography and human geography of the whole Hispanic American realm.

To the scheme of the International Map have been added certain modifications considered essential to the thoroughly scientific presentation of the cartographic status of those parts of the world which are not covered by one type of survey. These modifications are a further development of that feature of the International Map which distinguishes between surveyed and unsurveyed rivers and contours by solid and broken lines. They consist of a relative reliability diagram, incorporated in the legend, which classifies by appropriate symbols the type of surveys used in the compilation; and a pamphlet accompanying each sheet which lists the sources used in the compilation of the sheet and discusses the manner in which they are organized with respect to each other. Thus each sheet sets forth both our cartographic knowledge and our cartographic ignorance. In addition, by means of the relative reliability diagram and the pamphlet, it indicates to the consultant the character of the survey work which has been done in the area in which he is interested.

The cartography of Hispanic America as expressed by published general maps has been at low ebb for at least the past twenty-five years. During that period, except for the incorporation of a few of the more outstanding surveys, these maps have been little more than copies, one from another. In spite of the great advances that have been made during that period in developing the natural resources of Hispanic America and in constructing roads and railroads for the transportation of the products of that development to the market, such general maps as we have give but vague and frequently highly erroneous conceptions of the geography of the very areas in which this development has taken place. Naturally, on the sheets of our own map large areas must still be shown as unsurveyed. Naturally, too, over large areas in which there are good surveys of rivers and in which the location of towns is reasonably accurate we can still show elevations only by approximate contours. These contours, however, have been drawn only after exhaustive research into the best available physiographic knowledge and careful study of lists of altitudes.

SOME EXAMPLES OF NEW SOURCE MATERIAL

More and more of the compilation problems of all types with which we are confronted are being cleared up as the contacts which we have been able to establish with the Hispanic American governments, with development companies, and with individual explorers yield results. Within the past few months we have received, among many other surveys, five which are particularly noteworthy: a 1200-kilometer survey of the Magdalena River by triangulation and by airplane photographs; a group of plane-table surveys in northwestern Colombia which affords by close contours a picture of the junction of the northern end of the Central Cordillera and the Caribbean Plain; a plane-table survey of a large and hitherto little-known area south of Bogotá; the surveys for a new irrigation project in Peru which completes our collection of surveys of the coastal valleys of Peru; and a collection of traverses covering hundreds of miles of the Peruvian tributaries of the Amazon, which solves many of our problems and which permits at last the construction of a fairly good cartographic picture of that little-known region between the Perené and Ucayali Rivers called the Gran Pajonal. At the present time there are in the field four large parties doing survey work in cartographically critical areas that we have been able to assist in their preparatory work and whose surveys, when completed, will be immediately available for compilation.

The unpublished surveys received by the Society in 1925 include 51,000 square miles of high grade topographic surveys, 32,000 square miles of less accurate topographic surveys, and 8200 miles of traverses of various sorts; in 1926 there were received approximately 60,000 square miles of high grade topographic surveys, 30,000 square miles of less accurate topographic surveys, and 7500 miles of traverses.

It is a familiar matter to the geographer that maps on different scales are needed for regions which have reached different cultural levels. For example, the density of population in the United States and the high level of its material culture may need, especially in the eastern part of the country, topographic maps of large scale. The inch-to-the-mile maps of the U. S. Geological Survey are suited to the representation of detailed distributions except for such plot surveys or type surveys as are designed to show cultivated areas and the like by townships or even by farms. By contrast the distributions in Hispanic American countries are for the most part satisfied by a map on the millionth scale. In the more densely populated parts this scale is inadequate, and for these parts the compilation sheets of the millionth series and the source material are available for closer study and more detailed representation.

This source material which has been assembled for the map now forms a collection of the first magnitude. For detailed studies in individual areas it affords a base on a much larger scale than that of the published sheets. The collection, except for such sections as have been designated as confidential by the owners, is available at the Society to scholars. This is a matter of great importance in field work. A geographer or geologist, for example, who wishes to do highly detailed work in unit or type areas may want a large-scale map for field work just as he may want the small scale of 1:1,000,000 to represent his generalizations. For more rapid traverses in the field even the scale of 1:1,000,000 is sufficiently large since it affords an inch of space on the map to represent 16 miles, or about the length of an average daily traverse. For convenience in tracing traverses or in plotting distributions a small edition of each sheet is provided without the layer tints but with all other details.

For the use of those who wish to have a somewhat larger scale map but one still convenient for carrying in the field, the compilation sheets and the fair drawings as well as the reductions upon which they are based (all of which are on the scale of 1:500,000) are on file at the Society where they are available for study or for reproduction as, for example, in the case of the Tacna-Arica section of the La Paz sheet which was reproduced by the U. S. Geological Survey on the scale of 1:500,000 from our fair drawings for use as a base map for the plebiscitary and boundary commissions.

Parallel with the work upon the cartography of Hispanic America we have compiled a catalogue of the maps of Hispanic America in scientific periodicals, sheet map collections, atlases and books contained in the libraries of the American Geographical Society, the New York Public Library, the Library of Congress, the Pan American Union Library, and the libraries of Columbia, Yale, and Harvard Universities. Grouped and classified and accompanied by reliability maps and introductory articles on the general subject of Hispanic American cartography this catalogue will be published in six volumes. It is now ready for the press. The Millionth Map and its explanatory pamphlets, together with this catalogue, will afford a critical analysis of the cartography of Hispanic America. It will mark a point of departure in future cartographic work in Hispanic America since it will provide an ordered assembly of source material down to the date of publication.

TWENTY-THIRD ANNUAL MEETING OF THE ASSOCIATION OF AMERICAN GEOGRAPHERS

The Association of American Geographers met at Philadelphia on December 28, 29, and 30, 1926, for its twenty-third annual meeting. The sessions were held in Logan Hall of the University of Pennsylvania. Professor J. Paul Goode, of the University of Chicago, President of the Association for 1926, occupied the chair.

Members of the Association and others present were guests of the Geographical Society of Philadelphia at luncheon on December 28. On this occasion Mr. Alfred M. Collins and Mr. Henry G. Bryant, respectively President and First Vice-President of the Society, spoke a few words of greeting. Mr. Bryant, who is one of the original members and past President of the Association, referred to the fact that it was at Philadelphia in 1904 that the first meeting of the Association, then just founded on the initiative of Professor W. M. Davis, was held. He also spoke of the influence in both organizations of the late Professor Angelo Heilprin. Those who visited the library of the Society were interested to see there one of the original Melville-Bryant drift casks that had floated across the Arctic basin from Alaska to Iceland.

FIELD EXCURSIONS

There was a valuable innovation in the form of a field excursion. It was conducted by Professor Frank E. Williams of the University of Pennsylvania and led to the Chester valley at Valley Forge, some twenty miles west-northwest of Philadelphia. This gave the members an opportunity to appreciate the admirable selection of the site for this historic encampment of the Revolution at the point where the limestone Chester valley, etched down into the surface of the Piedmont, is flanked on the north by a longitudinal stretch of the Schuylkill River. This stretch strategically forms at this point the eastern continuation of the ridge bounding the valley on the north and adds another element of protection to the command of approaches provided by the bordering ridge and by the low hillocks within the valley itself.

This excursion will, it is to be hoped, be followed by others. The circumstance that the Association meets in different places should afford an excellent opportunity for studying the geography of the locality in which a given meeting is held. Heretofore the program has left little or no time for local investigation, and, unless a member undertook exploration on his own initiative, his acquaintance with the city or region in which he found himself might well be limited to knowing the relative positions of railroad station, hotel, and university and the means of transportation between them. Such a state of affairs seems an anomaly at a gathering of men professionally devoted to the study and interpretation of the environmental conditions under which we live in various parts of this earth. With the recent rapid advance of human and economic geography it would seem possible to arrange for each meeting a field excursion or study trip, preferably preceded by a preparatory paper outlining the general setting, which would provide an insight into man's mode of life in that region or city without in any way duplicating the heretofore more customary type of field trip, the geological excursion. The local member or members of the Association would of course be the indicated leaders of such an excursion and could probably prepare for it and carry it out without undue labor, as a result of local knowledge and, possibly, of practice with their own students. The choice of Nashville as the place for the next meeting, in December, 1927, affords a welcome opportunity of acquainting many members not familiar with it from personal observation with the geography of this interesting region and city.

Papers on Regional Survey Methods

To return to the present meeting, the final program announced twenty-six papers, of which all but two were presented. Three dealt with regional survey methods, twelve were primarily regional, including three on Greenland, two were in the field of historical geography, three and the presidential address were cartographical, and four dealt with general principles.

Possibly the most distinctive papers were the group dealing with the detailed regional survey methods with which a number of members of the Association are experimenting and about which they have reported at previous meetings (see *Geogr. Rev.*, Vol. 15, 1925, p. 322, and Vol. 16, 1926, p. 331). Professor V. C. Finch of the University of Wisconsin, in a paper entitled "Progress in the Field Mapping of Detailed Geographic Interrelationships," presented a sample map of a rural area in southern Wisconsin located partly in the driftless area and partly outside of it. On this map, the field survey for which had been carried out on the scale of four inches to the mile, geographical interrelationships were shown by means of symbols, one set of which indicated the physical basis as expressed by slope (three grades), soil (five subdivisions), and drainage, and the other set of which indicated land utilization as expressed in the following categories: crop rotation, permanent grass, woodland, farmsteads, idle land, industrial and commercial land. The combination of the two sets of symbols provides an exceedingly intimate representation of the geographical condition of a given region.

Professor D. S. Whittlesey of the University of Chicago, under the title of "Devices for Obtaining Geographic Data in the Field," reported on a somewhat similar experiment in field methods carried out in the upper Connecticut valley and based in part on the suggestions of Wellington D. Jones and C. O. Sauer (*Bull. Amer. Geogr. Soc.*, Vol. 47, 1915, pp. 520–525, and *Annals Assn. of Amer. Geogrs.*, Vol. 14, 1924, pp. 17–33; for four other papers on regional survey methods by Jones and Finch, by Whittlesey, by D. H. Davis, and by K. C. McMurry, see *ibid.*, Vols. 15 and 16, 1925 and 1926). Professor Whittlesey's method culminates in the preparation of two separate maps, one dealing with the environmental complex, the other with the cultural complex, rural or urban, as the case may be.

A third paper in this group, by Professor K. C. McMurry of the University of Michigan, dealt with "The Work of the Michigan Land Economic Survey." Ten per cent of the area of Michigan has now been covered by this survey, three counties in the northern end of lower Michigan and two separate counties in the Upper Peninsula. In addition to a series of printed maps of Ogemaw County in the former area showing separately topography, soil, and slope and vegetation cover, a number of manuscript maps of a township were exhibited showing the type of data collected, which, besides the above elements, include assessed value, form of land tenure, and tax delinquency.

The work represented by these papers is among the most distinctly geographic being done by members of the Association. It has been begun, it seems, partly because of the conviction of those carrying it out that geography has suffered from too much superficial generalization and that this generalization is in part connected with the attempt to treat large areas for which detailed intensive studies are still lacking. This point of view is already bearing its fruitful results, but it is to be hoped that it will be realized that there is room and justification for both methods in geography—the intensive detailed study of a small area and the broader synthetic discussion of a large area, each demanding its own technique.

REGIONAL STUDIES INCLUDING A SYMPOSIUM ON GREENLAND

A number of papers presented the salient characteristics of a given region or one of its geographical aspects. Mr. L. E. Klimm (introduced) of the University of Pennsylvania gave an interesting description of the life of the inhabitants of Aranmore, an outpost island group facing the Atlantic off Galway Bay, Ireland. Miss Ella M. Wilson of the State Normal College, Ypsilanti, Michigan, dealt with "Farmers and Farming in Cambridgeshire" on the basis of a recent field trip. Four other regional papers dealt mainly with some economic aspect of a given region, as follows: Professor S. S. Visher of Indiana University on the "Geography of the Indiana Oolitic Limestone Industry"; Mr. Henry F. James (introduced) of the University of Pennsylvania on "Some Influences of Geographical Factors in the Agricultural Development of Southeastern Pennsylvania"; Mr. Malcolm H. Bissell (introduced) of Bryn Mawr College on the "Geographic Aspects of the Pennsylvania State Highway System"; and Miss Esther S. Anderson (introduced) of the University of Nebraska on "A Geographic Study of the Potato Industry of Nebraska." In an excellent survey, Dr. O. E. Baker of the Bureau of Agricultural Economics reviewed the "Changes in Land Utilization in the United States, 1919–1926," illustrating his paper with maps showing the shift in agricultural area mainly from food crops to feed and fiber crops. Related to this paper and in the field of climatology was the discussion by Professor A. J. Henry of the Weather Bureau on "The Brückner Cycle in the United States."

The morning of December 30 was devoted to a symposium on Greenland. The introductory paper was by Professor W. H. Hobbs of the University of Michigan on "The First Greenland Expedition of the University of Michigan" (published in the *Geogr. Rev.* for January, 1927). Mr. S. P. Fergusson, of the U. S. Weather Bureau and the expedition staff, discussed the meteorological results. Professor W. Elmer Ekblaw of Clark University spoke on the "Local Character of Greenland Climatic Data" and Professor Charles F. Brooks of the same institution gave a brief critical summary of Professor Hobbs's recent "The Glacial Anticyclone" (*Univ. of Michigan Studies, Sci. Ser.*, Vol. 4). Professor Ekblaw earlier in the program presented another paper dealing with the "Geographic Response Complex of a Primitive Polar People." The tribe dealt with were the Cape York Eskimos.

CARTOGRAPHY, HISTORICAL GEOGRAPHY, AND GENERAL GEOGRAPHY

Three papers and the presidential address dealt with cartography. Professor Goode's address, given at the evening dinner on December 29 in joint session with Section E of the American Association for the Advancement of Science and entitled "The Map as a Record of Progress in Geography," presented an admirable rapid survey of the whole development of cartography in all its phases. Mr. S. W. Boggs (introduced), geographer of the State Department, presented "A New Equal Area Projection for a Map of the World." This projection is an interrupted net outwardly similar to Professor Goode's sinusoidal projection (see *Geogr. Rev.*, Vol. 14, 1924, p. 293), intermediate between it and the homolographic (Mollweide's). Dr. Helen M. Strong of the Bureau of Foreign and Domestic Commerce dealt with "Maps and Business." After a brief survey of the development of cartography among the trading nations of the sixteenth and seventeenth centuries she dealt with the use of maps in modern business, with special reference to the activities of the Bureau of whose staff she is a member. Miss I. J. Curnow (introduced), a pupil of Professor Lyde of the University of London and now lecturing at Wellesley College, contrasted the standard topographic maps of Great Britain and the United States.

There were two interesting papers in the field of historical geography. Miss Ellen Churchill Semple spoke on "The Templed Promontories of the Ancient Mediterranean." She traced the part played by these promontories from the time of the ancient navigators when they served as marks for coastwise sailing to the days of the Middle Ages, when Artemis, the patron deity of these sailors, had turned to St. Nicholas in the Greek Orthodox eastern Mediterranean and to the Virgin Mary, Stella Maris, of the western Roman Catholic Mediterranean. This paper will be published in a forthcoming number of the *Geographical Review*. Dr. Edward L. Stevenson of the Hispanic Society of America dealt with "Geographical Activities of the Casa de la Contratación," the great "hydrographic office" of the era of discovery in which navigators were trained and in which the standard model map, or *padrón real*, was prepared under the direction of such cosmographers as Juan de la Cosa and Juan Díaz de Solís.

Three papers dealt with general principles or general geography. Professor R. S. Platt of the University of Chicago presented "A Classification of Manufacturing Exemplified by Porto Rican Industries." Mr. Richard Hartshorne (introduced) of the University of Minnesota discussed "Location as a Factor in Geography." Mr. G. T. Renner (introduced) of Columbia University spoke on "Geographic Elements in the Concepts of Heaven."

Pioneer Belts

The evening of December 28 was devoted to a round table discussion for members of the Association on "Pioneer Belts" led by Dr. Isaiah Bowman of the American Geographical Society. This was the first occasion on which this undertaking was presented to the Association, the plan having already been outlined to the Division of Geology and Geography of the National Research Council and later to the Social Science Research Council (see *Geogr. Rev.*, Vol. 16, 1926, pp. 647–653).

Meetings of Allied Associations

Concurrently with the Association meeting the National Council of Geography Teachers met in Philadelphia on December 27, 28, and 29. There was a strong program of pedagogical interest. One feature of the meeting was "clinics" at which demonstration lessons were given with pupils from the local schools. Among the papers of general interest may be mentioned one by Professor J. Russell Smith of Columbia University on "Modern Concepts of Geography." The National Council meeting was also supplemented by excursions. Two major ones, the first under the leadership of Mr. Henry F. James and the second under that of Professor F. E. Williams, led to the South Jersey coastal plain region and Atlantic City and to the Schuylkill valley between Philadelphia and Reading. A number of minor excursions were made to industrial plants in the vicinity of Philadelphia.

As usual, several papers presented before the American Association for the Advancement of Science, which held its eighty-third meeting at Philadelphia from December 27, 1926, to January 1, 1927, were of interest to geographers. Among these may be mentioned especially the general address by Professor J. L. Myres of Oxford University on "Geographic Conditions of Ancient Greek Culture." Other papers were "Climatic Pulsations in Mongolia," by Professor C. P. Berkey of Columbia University and Dr. Frederick K. Morris of the American Museum of Natural History; the "Mapping of the Vegetation of Ohio," by Professor E. N. Transeau and H. C. Sampson of Ohio State University; "Factors of Significance in the Development of European Agriculture," by Dr. J. G. Lipman of the New Jersey Agricultural Experiment Station.

AMERICAN GEOGRAPHICAL SOCIETY

The December Meeting. The last regular monthly meeting of the American Geographical Society for 1926 was held on Wednesday, December 23, at the Engineering Societies Building, 29 West 39th Street, President John H. Finley presiding. Dr. Roy Chapman Andrews, leader of the Third Asiatic Expedition of the American Museum of Natural History, was the speaker of the evening. He described the work of the last few years in Mongolia, gave an account of the special difficulties of the past season, and outlined plans for the future. Of special geographical interest was his account of the methods employed in making rapid reconnaissance surveys for the general preliminary maps of the expedition. He emphasized the wide extent of country traversed, the difficulties that were overcome, and the supplementary sketches and sections so admirably constructed by Professor Berkey, the geologist of the expedition, and by his associate, Professor Morris.

Meetings of January and February. A special meeting of the Society was held on January 11 at the Engineering Societies Building, 29 West 39th Street, when the Council and Fellows had the pleasure of receiving His Royal Highness Prince William of Sweden, who honored the Society by making this his first public appearance in America. His address was entitled "Exploration in the Land of the Pygmies." By a series of motion pictures a great diversity of scenes was displayed of both landscape and people in Central Africa. President Finley presided and in introducing His Royal Highness dwelt not only upon the high public favor which the reigning house of Sweden enjoys in the esteem of the people of the United States but also upon the excellent qualities of the Scandinavian element in our population.

At the regular monthly meeting of the Society on January 25 Dr. John C. Merriam, President of the Carnegie Institution, delivered an address entitled "Cave Exploration and the Antiquity of Man." He spoke principally of the caves of California and emphasized the general absence of traces of early man in the cave deposits of that region. He also gave attention to the actual work of cave exploration and to the geologic and physiographic conditions under which caves originate.

At the regular meeting of the Society on Thursday, February 24, there was given a report by Professor William H. Hobbs of the University of Michigan of his field work in the season of 1926 on the Greenland Ice Cap and at its border. A published account of the work of the expedition appeared in the January number of the *Review* (Vol. 17). The lecturer dwelt on the results already accomplished, the theory of the glacial anticyclone which the field work is designed to test, and his plans for the season of 1927 in the same region.

Elections to Fellowship. At the December, January, and February meetings of the Society, President Finley presiding, there were presented with the approval of the Council the names of 236 candidates, who were duly elected as Fellows of the Society.

ANNUAL REPORT OF THE COUNCIL

New York, January 25, 1927.

To the Fellows of the Society:

During the past year the Society has published in the *Geographical Review* articles and maps of exceptional interest and importance, since practically all of them represent original field work. They deal with the frontiers of knowledge and represent diverse and stimulating points of view.

"In the Northwest of the Australian Desert," Frederick G. Clapp, embodied the results of exploration in a part of Australia from which we have had little modern scientific information. He gave an admirable regional description of the physiography and dealt also with special aspects of the question of settlement and development in Australia—a subject treated more broadly by Professor Griffith Taylor, of Sydney, in a paper entitled "The Frontiers of Settlement in Australia."

On the geography of South America there have been published at least five contributions of the first order. From personal observations and data gathered from many sources Robert Cushman Murphy gave an account of the remarkable "Oceanic and Climatic Phenomena Along the West Coast of South America During 1925." Shaw and Darnell have described the frontier region of southwestern Maranhão in Brazil and have illustrated their paper with original surveys. Raye R. Platt, head of the Society's department of Hispanic-American research, who spent several months of 1924 and 1925 in South America, has written on "Railroad Progress in Colombia" and on "Political Sovereignty and Administration in the Caribbean." The value of the latter contribution has been enhanced by an original map based on the compilations of the Society's Millionth series, showing the political geography in detail. Marbut and Manifold are the authors of "The Soils of the Amazon Basin in Relation to Agricultural Possibilities," a basic paper for the economic geography of the region. The senior author has traveled widely in that continent as a member of the rubber survey commission of the Department of Commerce; and he was able to amplify his geographical field work by a subvention from the Society. Professor Mark Jefferson in "Pictures from Southern Brazil" has supplied an illuminating analysis of one of the most important sections of Brazil, one of the results of field work on behalf of the Society in 1918.

Dr. Lauge Koch's "Ice Cap and Sea Ice in North Greenland" is based on his work as leader of the Bicentenary Expedition to the North of Greenland (1920–1923) and his earlier studies. Professor Gautier of Algiers, the eminent authority on Saharan geography, has written a most interesting paper on the Ahaggar. Of similar wide interest is Professor Boak's paper on the Faiyûm. Some of the technical papers have elicited much favorable comment, especially that by Gerard H. Matthes on "Oblique Aerial Surveying in Canada" and that by William Bowie on "Long Lines of Triangulation."

By bringing together so wide a variety of field studies and by encouraging the production of technical as well as descriptive papers, representing all branches of geography, the *Geographical Review* is able to keep in proper balance the several parts of the subject, favoring no one part at the expense of others but following on broad lines the way in which the subject is actually developing in the various centers of research throughout the world. The Society has always maintained the policy that its journal should bring to its Fellows and contribute to science the best that is available rather than become a medium for local or institutional expression only. Material published in 1926 includes 40 principal articles, 70 notes and 63 reviews.

The books and maps published by the Society during 1926 include the following:

1. CHINA: LAND OF FAMINE, by Walter H. Mallory.

Mr. Mallory was secretary of the International Famine Relief Commission and had exceptional opportunities for the study of the various causes and possible cures of famine. He has produced in this book a substantial contribution on the subject of famines. By his intimate acquaintance with Chinese life and customs he has been able thoroughly to describe and analyze the social, economic, and political causes of famine and the possible cures.

2. PEOPLING THE ARGENTINE PAMPA, by Mark Jefferson.

In a book displaying unusual ability and vigor of style and thought Professor Jefferson has supplied the historical, economic, and political background for Argentine life on the land today. By field studies in 1918 he was able to make thorough comparisons with the life of forty years ago as he knew it from six years of residence. It is a work of the first order of importance on the geography of South America.

3. INDEX TO THE GEOGRAPHICAL REVIEW, VOLUMES 1–15, 1916–1925, by Arthur A. Brooks.

In this volume of 432 pages, the Society has supplied a thorough analytical guide to the contents of the *Geographical Review* during the past ten years. Together with its chronological predecessor, the Index of the *Bulletin* of the Society published from 1852 to 1915, it supplies what is in effect a card catalogue of the most important geographical publications extending over a period of seventy-five years. The rapid rate of development of geography as a science in the past ten years, the critical nature of the statistics of population and commerce, and the many boundary changes have combined to enhance the importance of the geographical literature of the past decade; and this is reflected in the length and resourcefulness of the Index.

4. BIBLIOGRAPHIE GÉOGRAPHIQUE.

It will be recalled that a coöperative arrangement with the Association de Géographes Français and this Society was made in 1924 and has been continued since that time. Professor de Martonne, the secretary of the Association de Géographes Français, has sought the coöperation of other organizations, and, following the example of this Society, the Royal Geographical Society of London and the National Geographical Committee of Italy have given their adhesion to the plan. The Bibliographie has grown in size and variety of contents and now represents what we had hoped it might become when the original suggestion was made, a truly international bibliography, to which contributions would be made in a coöperative spirit, thus avoiding duplication of effort by a number of institutions.

5. The Society has encouraged the production at The Hague of successive volumes of PRACTICAL HINTS TO SCIENTIFIC TRAVELERS, by Professor H. A. Brouwer. Four volumes have now been published, the last volume having been received and announced to the Fellows during the past year. It contains authoritative articles on Egypt, Angola, Australia, Antarctica, Venezuela, and Haiti. It is in pocket size, substantially bound. With the other volumes in the series it offers a wide range of information and advice concerning travel, exploration, and research in countries most likely to tempt the field student.

6. Among the books announced in previous years there has been reprinted during 1926 (on account of continued demand for it by Fellows of the Society and others): George E. Nunn's THE GEOGRAPHICAL CONCEPTIONS OF COLUMBUS.

7. In the report for 1925 attention was called to a series of volumes on Arabian Geography and History prepared by Professor Alois Musil and in course of publication by the Society. During 1926 the first volume, entitled THE NORTHERN ḤEǦÂZ, has been published, and the remaining volumes have been edited and in part set up so that publication of them will be rapidly advanced in 1927 and completed in 1928. The volumes will be fully described in a special pamphlet soon to be distributed to Fellows of the Society, libraries, and interested scholars.

8. MILLIONTH MAP OF HISPANIC AMERICA.

Seventeen sheets have been published during the past year, making a total of 20 published sheets. Fair drawing is in progress on three additional sheets. Compilation on six others is completed, and compilation on seven others is under way. The fifty sheets published or compiled by the end of 1927 will include all of the Caribbean region and the West Coast and Andean regions of South America, with considerable extensions into the adjacent plains. During the past year the generous coöperation of institutions and companies who have placed original material at the Society's disposal has continued, and the Society's collection of source material has been increased by an extraordinarily large number of important surveys. In Colombia, Venezuela, and Peru these contributions have been especially notable. The Society has been able to assist in the preparation of several parties doing exploration work in critical areas at the present time, and their surveys will be placed at the disposal of the Society on completion.

9. Accompanying the first volume of Professor Musil's work is a map of THE NORTHERN ḤEǦÂZ in black and white and brown on the scale of 1: 500,000.

10. In the GEOGRAPHICAL REVIEW the following insert maps have been published: a map of southern Maranhão, by Shaw and Darnell, to accompany their paper on this section of Brazil; a map of a part of Western Australia, by Frederick G. Clapp, to illustrate the route that he followed and the geography of that section of Australia; seventy years of change in the course of the lower Colorado River have been depicted in a map by Dr. Godfrey Sykes accompanying a paper on the delta of the Colorado; a map of the distribution of the population in Japan by the dot system by Wesley Coulter.

In addition there have been many black-and-white maps of almost equal importance accompanying the letter press and dealing with many aspects of exploration and research. Among them may be mentioned a series of maps by Taylor on Australian conditions; a map of a part of the north coast of Honduras to illustrate a paper on the physiography of Honduras and based on the Society's 1:1,000,000 compilation sheets of Central America; and a detailed map showing the distribution of the population in Jamaica prepared on a base traced from the compilation sheets of the Millionth Map of Hispanic America.

THE SCHOOL OF SURVEYING

During the year a number of persons have taken advantage of the instruction facilities of the School of Surveying. The courses given them were arranged to meet their individual requirements, thus putting into effect one of the primary objects of the School. In addition numerous people have applied for technical information or advice on surveying and astronomical subjects, and five field expeditions were lent instruments by the School.

In order that the School may eventually become a place of study not only for the untrained man but also for the surveyor who wishes to keep in touch with up-to-date methods and make himself familiar with the latest improvements in instruments, a comprehensive system of reference files has been started, and a subject index is in course of construction and covers as many aspects of surveying as possible.

New instruments added to the School's collection during the past year include a Gurley Telescopic Alidade, a Wild Universal Theodolite, a Booth Bubble Sextant, and a Casella Precise Level. These instruments are 1926 models, and all embody new constructive ideas.

In coöperation with the Radio Broadcast Research Laboratory the subject of field wireless reception equipment was investigated, and very shortly it will be possible to obtain at a moderate cost a set weighing about twenty pounds, including batteries, suitable for rough usage by the inexpert and capable of picking up wireless time signals in any part of the world.

The computation of star time-tables in connection with the equal-altitude method of determining position is proceeding.

Studies have been continued by the staff of the School in connection with aircraft navigation in the polar regions and aerial phototopography, special attention being given to the development of the stereoscopic plotting methods. In this latter connection Mr. O. M. Miller visited Europe in the summer of 1926 in order to become acquainted at first hand with European practice in this respect.

Mr. Weld Arnold was lent to the Harvard Expedition to Benkoelen, Sumatra, for observing the total solar eclipse of January 14, 1926.

As a check on astronomical observations taken at the School, the position of the Society's building was accurately located by connecting up with the United States Coast and Geodetic Survey's astronomical station at the American Museum of Natural History by means of a tertiary triangulation. (Latitude 40° 49′ 59″ North; Longitude 73° 56′ 57.5″ West of Greenwich.)

OTHER ACTIVITIES

The Society has sent representatives to important scientific gatherings, including the annual meetings of the American Association for the Advancement of Science and of the Association of American Geographers at Philadelphia, December, 1926. It has also had two representatives at the annual meeting of the National Research Council, Division of Geology and Geography. This division has interested itself in a project proposed by the Society for the coöperative study by a number of institutions of the "pioneer belts" of the world. The object of the study is to develop a science of settlement as a guide to policy makers in government and as an aid in the opening up of uninhabited or sparsely inhabitated regions capable of fuller development. It is planned to make intensive studies on a comprehensive scale of selected frontier regions where experimentation in settlement is under way at the present time. By invitation the plan was thoroughly discussed not only before the National Research Council but also before the Social Science Research Council at its summer session at Hanover, N. H., August, 1926. It was the subject of a round-table conference on December 28, 1926, at the annual meeting of the Association of American Geographers at Philadelphia.

The Arctic expedition of Captain George H. Wilkins, which the Society endorsed, did a large amount of flying in high latitudes and has written a chapter of great importance in the history of Arctic exploration. Captain Wilkins' planes flew between Fairbanks and Point Barrow again and again, traversing hitherto unexplored sections of the Brooks Range north of the Yukon and demonstrating great skill in navigation and the practicability of the airplane for prolonged reconnaissance in high latitudes. In December, 1926, through the efforts of several groups of Detroit citizens, including the Detroit Aviation Society and especially the *Detroit News*, the expedition was reorganized, still more fully equipped with technical apparatus and planes, and thus given a fresh start. The original program will be taken up once more with greater promise of success.

LIBRARY ORGANIZATION

Additions to the library during the year comprise 915 books, 671 pamphlets, 7819 new issues of periodicals, 1777 maps, and 42 atlases. The collection now numbers: 85,802 volumes of books and bound periodicals; 10,329 pamphlets; 67,180 maps, and 1364 atlases.

As may be inferred from the above figures, the Society's collections now include the greater part of all geographical publications that constitute the source material of modern scientific geography. Through current accessions critically selected these collections are being kept up to date. Particular emphasis is now being laid on the organization of the collections specifically for geographical research. This is accomplished primarily through the building up of a highly competent personnel of assistants, all of whom are acquiring expert knowledge of geographical bibliography in relation to reference work. The competence of these assistants is continually increased by direct coöperation with members of the Society's research staff. In this connection should be mentioned certain mechanical aids to geographical research that are being maintained in addition to the usual card catalogue of books. These aids consist of a series of catalogues and files, all arranged according to a uniform scheme of classification covering the entire subject matter of geography. They include (1) a card catalogue of all books, all periodical articles of geographical significance, and all maps currently received; (2) a file of lesser notes, newspaper clippings, etc., relating to current events of geographical interest, such as: exploring expeditions in the field, new railways, dams, reclamation projects, and boundary changes. For this file the Society has amassed much information through a questionnaire sent to universities, government bureaus, and other institutions which habitually send out exploring expeditions. In addition there is (3) a file of memoranda embodying the results of any special investigations (largely of a bibliographical nature) carried out by members of the Society's staff and as yet unpublished. The library is thus enabled to contribute critical material to the reviews and notes in the *Geographical Review* as well as bibliographical data embodied in all of the Society's publications and to give consultants expert assistance, a condition peculiar to specialized libraries and vital to the sound progress of a research institution.

THE LECTURE PROGRAM

The speakers and titles upon the Society's lecture program during the past year are as follows:

Captain Robert A. Bartlett, "Hair-Seal Hunting off the Newfoundland and Labrador Coasts"; Mrs. Rosita Forbes, "From the Red Sea to the Blue Nile"; Professor David M. Robinson, "Explorations and Excavations in Asia Minor"; Col. Theodore Roosevelt and Mr. Kermit Roosevelt, "Explorations in Central Asia"; Dr. Knud Rasmussen, "Across Arctic America"; Dr. Roy Chapman Andrews, "Explorations in Mongolia."

The number of Fellows at the close of the year was 4907, of whom 400 are Life Fellows. In addition there are 6 Honorary Members and 38 Corresponding Members.

The report of the Treasurer submitted herewith gives a condensed balance sheet and a summary of the income and expenses of the Society.

PHILIP W. HENRY
Chairman

REPORT OF THE TREASURER FOR 1926

RECEIPTS AND EXPENSES

During the year there have been received from annual dues, interest on investments, and sales of publications	$74,431.83
There have been expended for salaries, house expenses, library, meetings, publications, postage, insurance, etc.	87,315.25
Balance charged against Special Deposit Fund	$12,883.42

CONDENSED BALANCE SHEET, DECEMBER 31, 1926

Cash	$24,534.56
Sundry balances and investments	87,282.73
Inventory of publications	10,625.00
	$122,442.29
Capital Account, Balance uninvested	3,818.52
Annual dues paid in advance	4,951.56
Special Fund for general purposes	50,290.49
Sundry deposits and reserves	26,710.73
Millionth Map Publication Fund, Balance	36,670.99
	$122,442.29

REPORT OF THE SPECIAL COMMITTEE

New York, January 20, 1927

The Committee appointed at the meeting of the Council held on December 16, 1926, to nominate officers for the vacancies to occur in the Council in January, 1927, beg to nominate the following named gentlemen for the offices designated and move that the same be approved and presented to the Society for election at its meeting to be held on January 25, 1927:

		Term to expire in
President	John H. Finley	January, 1928
Vice President	Alexander Hamilton Rice	January, 1930
Foreign Corres. Secretary	William Libbey	January, 1930
Treasurer	Henry Parish	January, 1928
Councilors	Edwin Swift Balch	January, 1930
	Banyer Clarkson	
	H. Stuart Hotchkiss	
	Walter B. James	
	Frank L. Polk	

John Greenough
W. Redmond Cross *Committee*
Paul Tuckerman

The "Bibliographie Géographique" for 1925. The twenty-fifth volume of the annual *Bibliographie Géographique*, published by the Association de Géographes Français with the collaboration of the American Geographical Society, the Comitato Geografico Nazionale Italiano, the Royal Geographical Society, and with the coöperation of the Fédération des Sociétés Françaises de Sciences Naturelles, is now available. The volume is distributed in the United States by the American Geographical Society.

Recent Publications

A Forthcoming Book on Polar Research. In view of the present activity in polar exploration the Society has prepared for forthcoming publication a book on polar research under the title "The Polar Regions and Their Problems." By this means it is sought to bring forward for analysis the main scientific aspects of Arctic and Antarctic work as distinct from the popular aspects of adventure and travel.

The book is divided into three parts. Part I (about 250 pages) is a symposium on the unsolved problems in polar research. It consists of thirty separate papers, all, except the three marked below with asterisks, expressly prepared for this book, each paper being a discusssion of outstanding problems in a given branch of polar geography by a specialist in that field. Part II (about 70 pages) is a general characterization of polar nature by Otto Nordenskjöld, the eminent Swedish Polar investigator and explorer, translated from his "Polarnaturen." Part III (about 180 pages) is a regional geography of the Arctic and Antarctic by Dr. Ludwig Mecking, professor of geography at the University of Münster and collaborator of the scientific results of the *Gauss* Antarctic expedition, translated from his recent "Die Polarländer." It is a description of the Arctic and Antarctic regions of the highest order, written according to modern geographical standards and based on the whole range of scientific polar literature.

In addition to numerous maps and photographic illustrations in the text the volume is accompanied by three colored maps: Nansen's standard bathymetrical chart of the Arctic Basin on the scale of 1:20,000,000, revised by himself, and, in a separate case, two physical maps, one of the Arctic in 1:20,000,000, and the other of the Antarctic in 1:30,000,000.

The following table of contents indicates the wide range of problems discussed and the equally wide range of contributors of many nationalities.

PART I: UNSOLVED PROBLEMS IN POLAR RESEARCH

Fridtjof Nansen . . . . Arctic Oceanography
Leader of the "Fram" expedition, 1893–1896
H. A. Marmer . . . . .Arctic Tides
Assistant Chief, Division of Tides and Currents, U. S. Coast and Geodetic Survey
H. H. Clayton . . . . The Bearing of Polar Meteorology on World Weather
Late forecaster, Argentine Meteorological Service, and author of "World Weather"
Sir Frederic Stupart . . . . Arctic Meteorology
Director of Canadian Meteorological Service
L. A. Bauer . . . . Terrestrial Magnetism
Director of the Department of Terrestrial Magnetism, Carnegie Institution, Washington
A. P. Coleman . . . . Arctic Geology, American Sector
Emeritus Professor of Geology, University of Toronto
I. P. Tolmachev . . . . Arctic Geology, Eurasian Sector
Late Curator of the Geological Museum of the Academy of Sciences, Leningrad
N. A. Transehe . . . . Classification of Sea Ice
Late Captain Commander, Russian Navy, member of the Russian Hydrographical Expedition to the Arctic, 1909–1915
A. V. Kolchak . . . . Arctic Ice*
Late Admiral, Russian Navy, oceanographer on Russian Polar Expedition under Baron Toll, 1900–1903
J. W. Harshberger . . . . Arctic Plant Geography
Professor of Botany, University of Pennsylvania
Leonhard Stejneger . . . . Arctic Animal Geography
Head Curator of Biology, U. S. National Museum, technical expert in Bering Sea Fur Seal Arbitration
Diamond Jenness . . . . Arctic Ethnology, American Sector
Ethnographer of the Canadian Arctic Expedition, Curator of Anthropology, Victoria Memorial Museum, Ottawa
V. G. Bogoraz and B. A. Kuftin . . . . Arctic Ethnology, Eurasian Sector*
Senior author: Ethnographer, Jesup North Pacific Expedition, specialist in tribes of northeastern Siberia
Knud Rasmussen . . . . Eskimo Ethnography and Anthropology
Leader of the five Thule Expeditions
Vilhjalmur Stefansson . . . Economic Resources and Possibilities in the Arctic
Leader of the Canadian Arctic Expedition, author of "The Friendly Arctic," etc.
D. H. Miller . . . . Political Rights in the Polar Regions*
Legal Adviser, American Commission to Negotiate Peace, 1919. Counselor at Law

Sir Douglas Mawson . . . . Problems of Antarctic Exploration
Leader of Australasian Antarctic Expedition, 1911–1914, Professor of Geology, University of Adelaide
Erich von Drygalski . . . . Antarctic Oceanography
Leader of the German Antarctic Expedition on the "Gauss," Professor of Geography at the University of Munich
Griffith Taylor . . . . Antarctic Meteorology, Australian Sector
Physiographer, British Antarctic Expedition, 1910–1913, late Australian Commonwealth meteorologist, now Professor of Geography at the University of Sydney

Jules Rouch . . . . Antarctic Meteorology, American Sector
Meteorologist, Second French Antarctic Expedition on the Pourquoi-Pas?, Commander in the French Navy

R. E. Priestley and C. E. Tilley . . . . Antarctic Geology
Senior author: Geologist, British Antarctic Expedition, 1907–1909, scientist, Northern Party, British Antarctic Expedition, 1910–1913; junior author: Demonstrator in Petrology, University of Cambridge

R. E. Priestley and C. S. Wright . . . . Antarctic Ice
Geologists, British Antarctic Expedition, 1910–1913, now on faculty of University of Cambridge

R. N. Rudmose Brown . . . . Antarctic and Sub-Antarctic Plant Geography
Naturalist, Scottish National Antarctic Expedition, 1902–1904, Professor of Geography, University of Sheffield

R. C. Murphy . . . . . Antarctic and Sub-Antarctic Animal Geography
Associate Curator of Marine Birds and Assistant Director, American Museum of Natural History, New York

R. E. Byrd . . . . Polar Exploration by Airplane
Leader of the airplane flight to the North Pole, Lt. Commander, U. S. N.

G. H. Wilkins . . . . Polar Exploration by Airplane
Member of the Canadian Arctic Expedition, 1913–1917. Leader, Detroit Aviation Society's Arctic Expedition 1926 and Detroit News-Wilkins Expedition of 1927

Umberto Nobile . . . . Polar Exploration by Airship
Flight Commander of the Amundsen-Ellsworth-Nobile transpolar flight, General in the Italian Army

Lincoln Ellsworth . . . . Polar Exploration by Airship
Joint Leader, Amundsen-Ellsworth North Polar airplane flight, 1925, and Amundsen-Ellsworth-Nobile transpolar flight, 1926

Robert Bartlett . . . . Ice Navigation
Commander of Peary's vessels and of the "Karluk" on the Canadian Arctic Expedition

O. M. Miller . . . . Air Navigational Methods in the Polar Regions
American Geographical Society's School of Surveying

PART II: GENERAL CHARACTERIZATION OF POLAR NATURE

Otto Nordenskjöld . . . . Translation of "Polarnaturen," Stockholm, 1918
Leader of the Swedish Antarctic Expedition, Professor of Geography, University of Göteborg

PART III: REGIONAL GEOGRAPHY OF THE ARCTIC AND ANTARCTIC

Ludwig Mecking . . . . . Translation of "Die Polarländer," Leipzig, 1925
Collaborator of the scientific results of the German Antarctic Expedition on the "Gauss," Professor of Geography at the University of Münster, author of "The Ice Drift in Baffin Bay as Controlled by Current and Weather."

GEOGRAPHICAL RECORD

NORTH AMERICA

Moisture Belts of North America. The accompanying map of "Moisture Belts of North America" illustrates a new interpretation of the moisture factor in vegetation distribution. It aims at a closer approximation to reality than the time-honored map of mean annual precipitation: for precipitation tells only half the story, and of the other half, evaporation, we know little. Arbitrary though it must be as yet, recognition of the evaporation factor is an important step forward. Köppen has undertaken it in his classification of climates of which "Die Klimate der Erde" (1923) is the most recent exposition (his map, Plate 1, is a reproduction of the black-and-white map of Professor Ward's review of his work of 1918, *Geogr. Rev.*, Vol. 9, 1919, pp. 188–191). Eric McDougall, of the Canadian Meteorological Service, has adapted Köppen's findings to ecological purposes. He has drawn the map of moisture belts for the *Geographical Review;* the comparative vegetation map is redrawn from his paper on the subject in the October, 1925, number of *Ecology*.

Assuming that evaporation is a function of temperature, Köppen worked out the relation of precipitation to temperature along the critical limits where precipitation and evaporation are in equilibrium. Regions with less than the critical amount of precipitation have a "steppe climate"; those with less than half the amount a "desert climate." On Mr. McDougall's map those belts are designated semiarid and arid respectively, and he adds two more belts by doubling the precipitation values, thus making semihumid, humid, and wet. Broadly speaking the corresponding vegetation types are desert, semidesert, grassland, forest, and luxuriant forest.

In the temperate zone another factor of great importance is the seasonal distribution of rain in relation to the seasonal range of temperature. Köppen made allowance for this factor by deducting 30 per cent of the annual precipitation in regions of summer rain and adding a like amount for winter rain. On the map of moisture belts Mr. McDougall distinguishes the regions of summer rain (three successive warm months with over one-third of total precipitation and three successive cold months with less than one-sixth), winter rain (summer proportions reversed), and neutral (uniform distribution). Grasses are favored by summer rainfall. This is evidenced in the vegetation map of North America, where they flourish in the semiarid region of summer wet season and, aided by fire conditions, tend to invade the humid belt where summer rainfall prevails. On the other hand winter rainfall seems to be of little use to most types of vegetation except the evergreen conifers.

In tropical climates the length of the dry season should be taken into consideration. In arctic climates, the persistence of the snow cover is of importance. Mr. McDougall points out that his general formula does not appear to be applicable in polar and alpine regions. This is true of the similar principle employed by Dr. Paul Hirth in his paper "Die Isonotiden," discussed elsewhere in this *Review*.

Tree Planting on the Prairie. After a protest against the common conception of North Dakota as "a region without a tree," Mr. Charles A. Gillett in "Forests and Forestry in North Dakota" (*Journ. of Forestry*, Vol. 25, 1927, pp. 38–43) proceeds to discuss the need for conserving and increasing the woodlands of the state. While North Dakota could not have been described as densely wooded even before pioneering days, it is certain that settlement was accompanied by considerable forest destruction. The consumption of wood by steamboats on the Missouri River in past days alone denuded a large acreage.

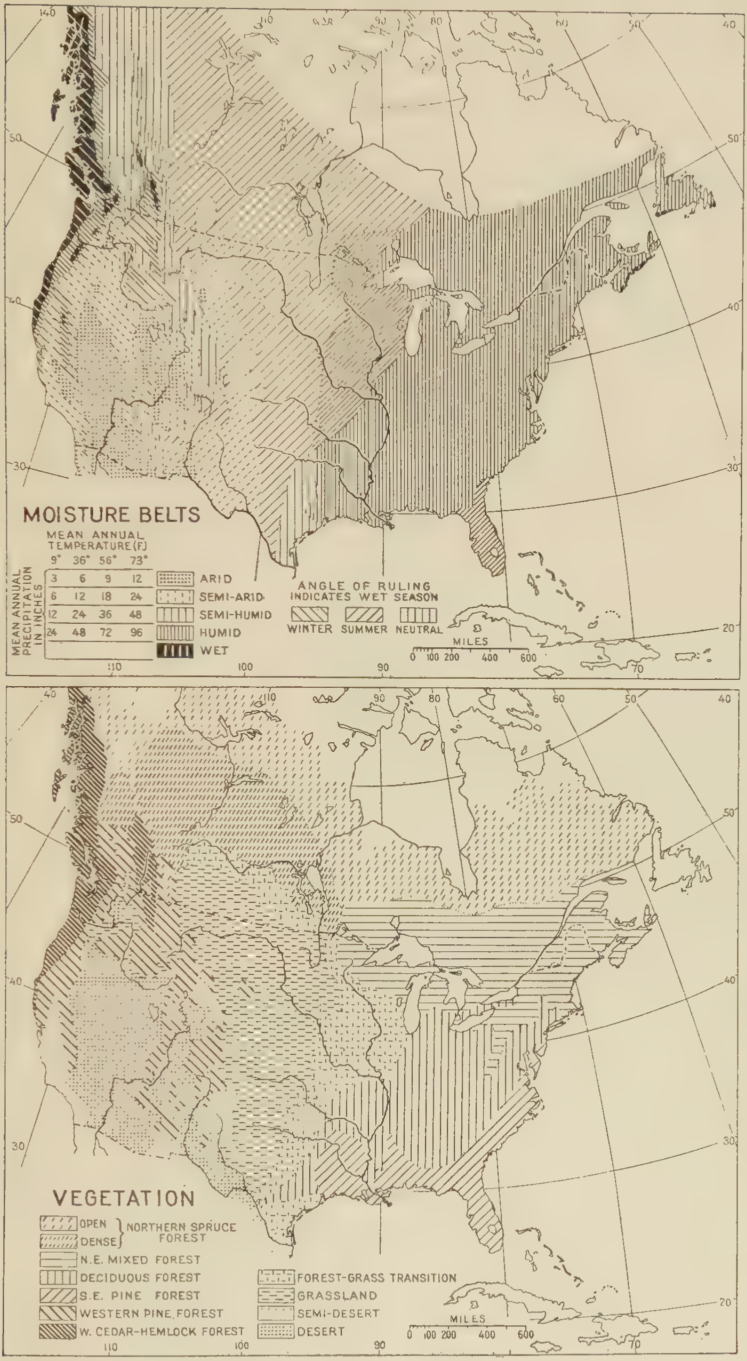


FIG. 1—Map of moisture belts of North America (drawn for the *Review* by Mr. McDougall) compared with a vegetation map of North America (redrawn from *Ecology*, Vol. 6, 1925, facing p. 325). Scale of maps approximately 1 : 16,000,000.

At present North Dakota has not much over 500,000 acres in natural and planted woodland, that is only about a hundredth part of the state. The greater part of the forested area is contained in five naturally wooded sections, the Turtle and Pembina Mountains, the Devils Lake region, and the Red River and Missouri River valleys; and rapid cutting is in progress for the most part. The special afforestation need is for shelter-belt purposes. This the government has encouraged since the establishment of "timber claims" in the early seventies, when 160 acres of land could be had free if a definite number of trees were planted and maintained for 10 years. Subsequently aid has been given in tree planting itself. One of the chief difficulties encountered is to induce the tenant farmers, who operate 34 per cent of the farms of the state, to undertake the extra labor involved.

The advantages to be reaped from the planting of shelter belts are being amply demonstrated in Canada. An account of the present status of the work there, which is under the Forest Service, is given in *Natural Resources, Canada*, for January, 1927. In 1926 five and a half million trees were sent out by the Service for planting on prairie farms, and it is planned to send out eight million in 1927. Since the inception of the scheme in 1901, 87,500,000 trees have been planted, or 32,000 acres. From the older plantations seeds and cuttings have been obtained, and a good deal of timber for farm use. The Service requires applicants for trees to prepare the ground thoroughly, inspects the farms, and gives advice as to care of the trees. As a result of the policy the prairie landscape is being greatly changed in many sections.

The Topographic Map of New York State Completed. The publication in December, 1926, of the "Wellsville Quadrangle," covering part of Allegany County, marks the completion of the topographic mapping of New York State. The final sheet shows a part of the well dissected Allegheny plateau. The Genesee River flows across the western portion and here occupies a broad mature valley in which features of glacial origin are to be observed.

The completed map of the state is in 254 sheets, on the scale of one inch to one mile, or 1 : 62,500. The survey was executed by the U. S. Geological Survey in coöperation with the New York State Engineer, the work commencing in 1888. The problem now confronting the state is the revision of the older sheets.

Besides New York the states of Connecticut, Delaware, Maryland, Massachusetts, New Jersey, Ohio, Rhode Island, and West Virginia and the District of Columbia have been completely mapped. Over forty-two per cent of the total land area of the country has now been surveyed by the U. S. Geological Survey, in its plan of making a standard topographic map of the United States; and over three thousand quadrangles have been published. As Major Bowie has pointed out in a note on "The Topographical Map of the United States" (*Geogr. Rev.*, Vol. 11, 1921, p. 441), a large part of this area needs to be resurveyed because of the improvement in methods and the greater accuracy demanded by the map makers. In the past, progress has been hampered by lack of funds. Improvement in this respect may be looked for as a result of the Temple Act, passed in 1925, authorizing appropriation for completion, " . . . within a period of twenty years from the date of the passage of this act, a general utility topographical survey of the territory of the United States, including adequate horizontal and vertical control, and the securing of such topographic and hydrographic data as may be required for this purpose, and the preparation and publication of the resulting maps and data."

Unusual Dust Storms in Illinois. On June 6 and 7, 1926, wind and dust storms of a good deal of intensity and of a nature hitherto unknown in Illinois swept over restricted and scattered areas in the northern part of the state, not only utterly destroying the corn crop in some fields but actually removing great areas of the top soil. Evidently these storms were small secondaries accompanying a storm area of considerable size.

One such secondary storm passed a few miles south of Champaign and Urbana in the east-central part of the state. It was accompanied by a strong wind from the west and southwest; but there was no tornadic whirl, and there was no damage to trees, buildings, or to most crops. Only the cornfields showed the marks of its passage, and only those fields which had been fall-plowed and whose surface was either nearly level or sloped more or less to the west. The ground on these fields was very dry; the top soil was loose; the surface particles were easily picked up by the wind or driven ahead of it until the young corn plants were so bared by its action that their hold on the ground was loosened and they too were swept away.

Out in the road beyond the fields the ditches were filled with a very dark gray—almost black—evenly sorted silt or coarse loess, which here and there was heaped up like snowdrifts two or three feet or more in height. In a few places these drifts reached to the top of the fence posts. They were ripple-marked like sand dunes and showed a few miniature blowholes. In other places the silt simply covered the leaves of the weeds and clung to the stems, much as snow does.

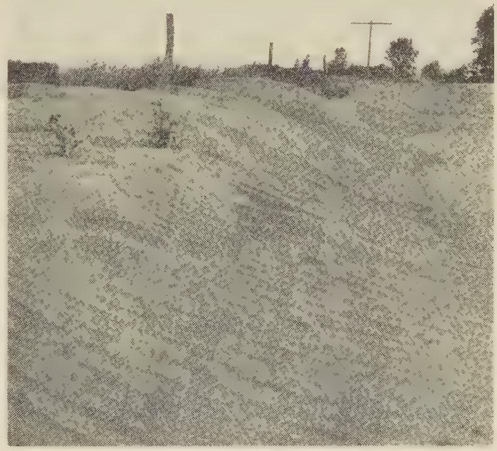


FIG. 1—Deposit south of Myra, Ill., after dust storm of June 6, 1926.

The extremely even character of the material makes it evident that the soil particles underwent quite thorough sorting as they were deposited because of some slackening of the wind. In the turning furrows at the edge of the fields the coarsest material seems to have been deposited, giving a sort of pattern, with the dark deposit in the furrows and the lighter, lower soil showing as streaks along the ridges between them. In the road was the very uniform silt; and the fine clay was carried on, to be dropped perhaps at some quite distant point.

Although such storms are common in the arid west, no one recalls having experienced anything of the sort in this part of the country.

DEETTE ROLFE

SOUTH AMERICA

A Norwegian Settlement in the Galápagos. Norwegian emigration shows marked fluctuations, apparently depending in the main on fluctuating periods of prosperity at home. Thus may be interpreted the figures for the last few years, which have been a period of general depression. Norse emigration has been almost entirely to the United States and Canada. In 1923 and 1924 the United States quota, 12,202, was filled, the annual number of arrivals being about double that of the preceding three years. The Immigration Act of 1924 reduced the quota by about half (6453), and the quotas for Sweden and Denmark suffered similarly. This limitation would seem to have turned the attention of the Scandinavian countries to other fields. For instance, an article by Otto Nordenskjöld, "Geografiska betingelser för nordisk kolonisation i Sydamerika," appeared recently in *Ymer* (Vol. 45, 1925, pp. 35–50). Argentina offers an obvious field, but it is surprising to find Norwegians settling in the Galápagos. Yet such a movement was initiated in 1925. The beginnings of this interesting experiment are described in Volume 1 of the *Norsk Geografisk Tidsskrift* (1926) by Alf Wollebaek under the title "El Archipiélago de Colon."

Ten Norwegian colonists landed on Santa Maria (Floreana, or Charles Island), one of the smaller islands of the group, on August 10, 1925. They established themselves on Post Office Bay, the best harbor of the group and already boasting a post office—the simplest post office in the world, the old bucket in which the whalers were wont to put their letters! Here accommodations were set up with material brought from home. Fresh water was not to be found near the coast, and the colonists are dependent on supplies brought by ship from Panama or Santa Cruz and stored in large iron cisterns. After the shore establishment had been put in order and fishing commenced some of the colonists took up farming in the higher parts of the interior where a few small fresh-water ponds occur and a spring with good drinking water.

Ecuador has need of population, but her efforts to attract immigration have met with little success in the past. The present state of affairs is described by Dr. Francisco Banda C., "Immigration and Colonization Problems of Ecuador," in the December, 1926, number of the *Bulletin of the Pan American Union*. Four regions available for settlement are described—in the Provinces of Pichinga and Manabi, the Eastern region as a whole, and the Galápagos. The strategic situation of the last-named has led to the clause in the legislative decree of 1913 that "at least three-quarters of the families who colonize the Galápagos Islands must be Ecuadoreans and the remainder from countries having no controversy pending with Ecuador." By reason of the present lack of facilities for individual colonization settlement is chiefly by contract with colonization companies. The terms of the contracts are generous. Certainly this is the case with the Norwegian group described above, the Floreana Company. It has received 20 hectares of land in Santa Maria for each colonist and 100 hectares of government land in each island where conditions are suitable for their colonization. The Company, furthermore, has free whaling rights for 15 years and the first right to renewal for another 15; a free monopoly of the coal and oil business, which has considerable possibilities in view of the situation of the Islands with respect to the Panama Canal; exemption from harbor dues for the export and import of the company's goods; and a monopoly of these concessions for the 15 years of the contract. It is reported that other Norwegian groups to the total of between four and five hundred persons have followed the Floreana Company.

Since the above was written a report has been received from the American-Scandinavian Foundation of New York which suggests that the experiment of Norse colonization is likely to be short-lived. The settlers are finding it difficult to become acclimated. The whaling and canning industries, from which much was expected, do not promise to be profitable on account of competition from the mainland. "On the whole, this attempt at colonization has been considered a failure."

EUROPE

Regions of Declining Population in France. The map, Figure 1, helps explain concern in France over her population problem. The black patches show areas where population increased or suffered only a slight diminution (under 5 per cent) in the period 1881–1921. The areas left blank show an average decline of over 22.5 per cent. The map is based on a more detailed map by A. Demangeon and

M. Matruchot ("Les variations de la population de la France de 1881 à 1921," *Ann. de Géogr.*, Vol. 35, 1926, pp. 499–510), itself a reduction of and generalization from a large-scale map in which population changes were worked out by cantons, a division small enough to give an adequate idea of the changes and their significance.

During the forty-year period under consideration four-fifths of the cantons lost in population. The greatest losses occur over six broad areas. Lower Normandy and the adjacent countryside have suffered not only from migration of the country population to the towns but by the change in agricultural practice from crops to cattle raising. Twelve cantons of the "red zone" in the war-devastated area lost over 50 per cent of their population. The calcareous plateaus of the east, in early days the choice settlement lands, find that the out-of-date agriculture of their grainfields cannot meet foreign competition. It is natural enough that, with improvements in communication, the high mountain regions should lose population. Here a clear distinction can be drawn between the southern Alps, drier and poorer in pasture and arable land, and the northern Alps, where the loss has been smaller. The poorer parts of the Central Massif where the birth rate yet remains comparatively high have also lost population by emigration.

The most surprising decline is in Aquitaine. Here are fecund earth, benign climate, opportunity for cultivating an infinite variety of crops; but the pleasant fields "die for lack of men." It is worth while quoting a specific case cited by Max Turman in a recent discussion of the problem (La problème de population, *Semaines Sociales de France, Grenoble, XV^e^ Session, 1923*). The arrondissement of Villefranche lost over 40 per cent of its population from 1851 to 1921. This is definitely ascribed to the practice of keeping families down to one child to avoid excessive subdivision of the tiny farms. But lack of hands so diminished the yields that during latter years (1879–1908) the land declined in value by 70 per cent, whereas in Brittany, where families continue large, values increased 40 per cent. Breton families have been satisfactorily colonized in Villefranche.

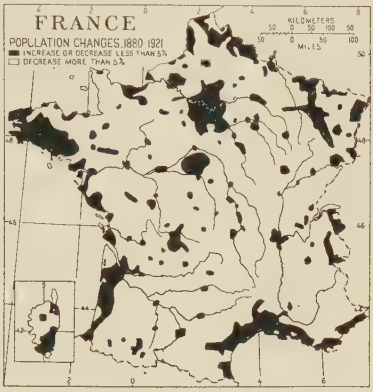


FIG. 1—Population changes in France between 1881 and 1920. The white areas show significant decrease.

In contrast the areas of increased population are the industrial north, the Parisian region, the urban and industrial centers, western Brittany, and the coasts generally. It is of some interest to note that in spite of war losses the "active" population in the period 1906 to 1921 increased by some half million, chiefly by the entry of women into gainful employment during the war. While the number in agriculture remained substantially the same, the big industries, business, transport, and the professions increased notably (Marcel de Ville-Chabrolle: La population active de 77 départements français en 1906 et en 1921, *Bull. Statistique Gén. de la France*, Vol. 16, 1926, pp. 65–110).

When the 1921 census was taken the population had not recovered from the dislocations caused by the war; hence the census of 1926, the results of which are now appearing. *L'Économiste Français* for January 15, 1927, gives the preliminary figures issued by the *Journal Officiel.* The decade of 1911 to 1921 had shown a loss in population even with the addition of the one and two-third millions of Alsace Lorraine. The figure for 1926 shows an increase of some 1½ millions. The total, exclusive of army, navy, and merchant marine in foreign fields, is given as 40,743,851. Two-thirds of the increase is foreign, and foreigners constitute about six per cent of the total population. One-third of the 90 departments show a decrease from the figures for 1921. Decline continues over the greater part of the Central Massif, and from this region stretch two broad zones of diminishing population northwest to Normandy and to the Vendee. The Landes, a department of the Pyrenees, the southern Alps, and a part of the eastern plateaus also show decrease; and the most notable feature is that the whole of Brittany is so affected.

AFRICA

Lake Nyasa and the Shire Valley. The fluctuations in level of Lake Nyasa have an important bearing on the flow of the Shire River, which in turn affects transportation. Until 1910 navigation on the upper and lower river—the middle stretch of rapids is not navigable—afforded the chief means of communication in Nyasaland. During the period of low lake level following this date the upper Shire became cut off from the lake, and the expansion known as Lake Malombe, which appears on the maps as a body of water 15 miles long and 8 to 12 miles wide, dried up completely. The confluences of the larger tributaries also were choked by bars and the growth of vegetation.

Some years ago Dr. F. Dixey, the government geologist, pointed out the cyclical nature of the variations in the lake level and its correspondence with sun-spot numbers, a relation similar to that obtaining for Lakes Victoria and Albert (see the note "Sun Spots and Variation in the Levels of the Central African Lakes," *Geogr. Rev.*, Vol. 16, 1926, pp. 142–143). He also suggested that with the approach of a period of sun-spot maximum the level of the lake would rise again and the river channel might be reopened. How his prediction has been confirmed is shown in the Annual Report of the Geological Survey Department of Nyasaland for 1925. The maxima of Lake Nyasa gauge readings at the outlet, Fort Johnston, rose from 12 feet 8 inches in 1920 to 15 feet in 1925. During the rainy season of the latter year the upper Shire cut through the barrier at the head of Lake Malombe, reëstablishing the lake. The natives of the vicinity, who had steadily encroached on the former lake bed, suffered much loss in their maize and rice gardens. Along the river itself much damage also was done by flooding and from the deposition of coarse material washed down by the tributary streams. Dr. Dixey in a letter dated the end of December, 1926, says that the present rainy season promises to be as heavy as the last two and that monthly readings of lake levels show consistent increase over corresponding readings of the previous year.

In his report, "The Physiography of the Shire Valley, Nyasaland, and its Relation to Soils, Water Supply, and Transport Routes" (Zomba, 1925), Dr. Dixey expresses the opinion that once the flow of the Shire were reëstablished in adequate manner there would be no difficulty in keeping it open by ordinary methods of river conservation. Any conservation scheme, however, would need to have due regard to the seasonal and longer range variations of Lake Nyasa, for even in the days of navigation the river was subject to periods of low water during which navigation might be suspended.

In addition to transport facilities river conservation would add to the power potentiality of the Murchison Rapids section and would improve the water supply for domestic and agricultural needs, among other means by local raising of ground water level. Water is an important question in the valley economics. Three main categories of agricultural land may be recognized here. The floor in general is a broad faulted and tilted valley plain worked over by the river and its tributaries in courses repeatedly modified by faulting up to very recent geological times. The older valley plains are mostly overlain by a thin gravelly soil, in consequence of which and of lowering of the water level by the incising streams they are apt to be waterless. However, in the depressions there are patches of soil which afford good tobacco land.

Some of the higher hills rising from the floor are doubtless relicts of the pre-rift topography, and their residual soils are likewise suitable for tobacco. The newer alluvial plains for the most part have a light fertile soil and constitute valuable cotton lands. In the upper valley their water supply is generally satisfactory: in the plains of the lower valley deep boring becomes necessary.

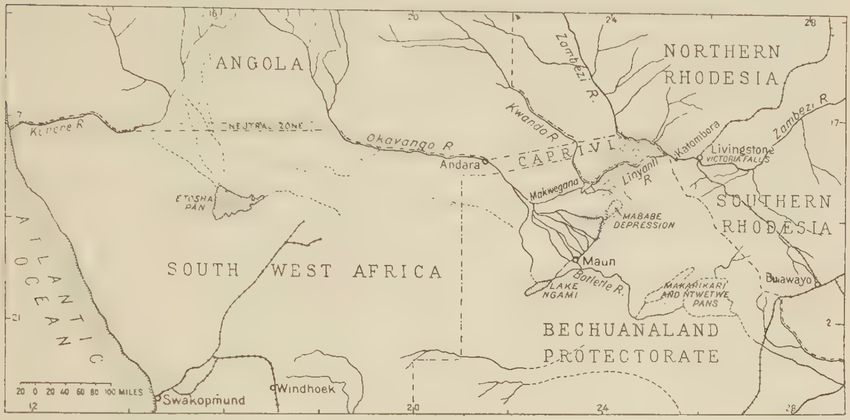


FIG. 1—Map of the northern Kalahari redrawn from Plate I of Dr. A. L. du Toit's report. The area that would be submerged by the proposed dam at Katombora, shown in stipple, is added from Plate V. Scale of map approximately 1 : 17,000,000.

The Kalahari Reconnaissance, 1925. Whatever the scientific merit of Professor E. H. L. Schwarz's scheme for the "redemption" of the Kalahari by the creation of vast artificial lakes (see the *Geogr. Rev.*, Vol. 11, 1921, pp. 623–626), it has at least given much publicity to the South African drought problem. In particular it has led to an important field investigation, the Kalahari Reconnaissance of 1925, carried out by the Union Government. The expedition, led by Dr. A. L. du Toit, director of irrigation, confined its attention to the northeastern part of the Kalahari, the territory between the Okavango and Zambezi (Report of the Kalahari Reconnaissance of 1925, Union of South Africa, Pretoria, 1926).

The Okavango is a remarkable stream. At Andara, where it enters the Caprivi Salient, the Okavango is almost as large as the Zambezi above the Falls. Ninety miles down stream it breaks up into widely diverging branches flowing through vast swamps, totaling several thousand square miles in area, and patches of forest, "a picturesque country teeming with game and only sparsely inhabited." Most of these branches unite on a curving arc draining northeast to the Mababe, southwest to the Ngami, and in time of heavy flood reaching as far as the Makarikari depression by the Botletle. (On this branch Professor Schwarz has a paper in the *Geogr. Journ.* for June, 1926.) In years of abnormal rains some water escapes to the ocean via the Linyanti (lower Kwando) and Zambezi. As regards the enormous loss of water, the Okavango delta may be compared with the Sudd region of the White Nile.

Under the conditions Dr. du Toit believes that from the waters of the Okavango or the Linyanti alone only minor conservation schemes could be carried out. Any large-scale measure must make use of the waters of the Zambezi. Such a project is given in outline. By means of a 60-foot dam on the Zambezi at Katombora, in the rapids section above the Falls, enough water could be impounded to irrigate a half million acres and in addition to develop hydro-electric energy up to 120,000 horse power without interfering either with the present power concessions or with the scenic beauty of the Falls.

While such a project is feasible from the engineering standpoint many other factors are involved. Provision of water is not all. To quote a recent report of the United States Department of the Interior, "Past experience in this [United States] and other irrigated countries is conclusive that solvent reclamation requires a program of settlement and farm development." As Dr. du Toit points out, considerable sums have been expended on irrigation works in the Union, and in some cases these have not yet been fully taken up. The locale of the project—in the Bechuanaland Protectorate—is far away. The only manner in which the Union would benefit by its establishment is in amelioration of climate, one of the essential features of Professor Schwarz's scheme. Dr. du Toit considers such influence negligible. He lays stress on the amount of water already being evaporated and the character of the rainfall, primarily in summer thunderstorms. The Colonial Office Report on the Bechuanaland Protectorate for 1925–1926 states that not only the Zambezi project but the minor schemes suggested are beyond the present resources of the administration. The natives, now numbering about 150,000 for the entire territory, or little more than one person to two square miles, probably stand in no need of the benefits that would accrue; and the projects would involve the acquisition of tribal lands. White settlement would demand study of crops and transportation problems. The tsetse fly is already known in the region; and further settlement, white or native, would probably call for control measures against its increase.

There is also the political aspect. Impounding of the Zambezi and Linyanti waters would flood a part of the Caprivi Salient in the mandated territory of Southwest Africa, some land in Southern Rhodesia, and a small corner of Northern Rhodesia. Similar considerations, it may be noted, would affect conservation measures on the Kunene, in its lower course the boundary river between Southwest Africa and Angola (see note below).

In passing, reference must be made to the valuable collaboration of the Union Defence Air Force. "Reconnaissance from the air enabled information to be obtained of the nature of the country, of the evolution of its river systems, seasonal and progressive shiftings of the courses of the channels, which could not have been gathered from the journeys on the ground alone. The flights also enabled a good idea to be acquired of the nature of the country which lay outside the narrow belts to which the party's field operations were naturally restricted."

Agreements Between South Africa and Portugal on the Kunene River. The "Agreement between the Government of the Union of South Africa and the Government of the Republic of Portugal in relation to the Boundary between the Mandated Territory of South-West Africa and Angola" (*Treaty Series No. 29*, 1926), signed at Cape Town, June 22, 1926, settles a dispute dating back to the Treaty of 1886 between Portugal and Germany. The boundary is defined thus: "The boundary between the Territory and Angola is accordingly declared and agreed to be the middle line of the Kunene River, that is to say, the line drawn equidistant from both banks, from the mouth of the said river up to a point at the Rua Cana Falls, above the crest or lip where the said middle line crosses the parallel of latitude, passing through the beacon placed on the left bank of the said river in July 1920, by a joint Commission appointed by the British and Portuguese Governments. This beacon is placed on a large rock at the top of the cascade or rapid which leads to the vertical waterfall at the head of the main eastern gorge of the Rua Cana Falls."

This is in accord with Portuguese claims. Germany had sought a line 11 kilometers farther north. The strip between the two lines was declared a neutral zone in 1916, and the present Agreement stipulates that it shall so remain until the boundary has been demarcated (see map, p. 329). Demarcation is provided for by a joint commission and is to be carried out "in the first favorable season."

Contingent on the settlement of the boundary is the "Agreement between the Government of the Union of South Africa and the Government of the Republic of Portugal regulating the Use of the Water of the Kunene River for the purposes of generating Hydraulic Power and of Inundation and Irrigation in the Mandated Territory of South-West Africa" (*Treaty Series No. 30*, 1926), signed at Cape Town, July 1, 1926.

The Agreement provides for mutual advantage in the use of the waters of the river and specifically states the conditions under which a dam may be built across the Kunene River in Portuguese territory, "not more than 3 kilometers upstream" from the boundary beacon on the river, and an intake canal constructed for the benefit of irrigation in Mandated Territory. The Union's first concern is stated to be on behalf of the Ovamboland natives, and for this purpose she has a right to half the flood waters of the river. If water is diverted for any other purpose, compensation is to be made to the Portuguese government. It is further provided that no diversion of water shall be made by either government to the disadvantage of power development farther downstream.

AUSTRALASIA AND OCEANIA

Natural Regions of Western Australia. An important paper by E. de C. Clarke, "Natural Regions in Western Australia," appears in Volume 12 of the *Journal of the Royal Society of Western Australia*. Here are the natural subdivisions of a vast, monotonous, and for the most part dry country. Elevation here is of little account; rivers, whether they be regarded as ways of communication or drainage, are negligible; vegetation, though far from scanty, exhibits insensible gradations over great areas; rainfall, by its very scarcity except in the southwest and the extreme north, is of tremendous importance; ground water assumes a rôle of unusual gravity in the economy of the country; geological conditions exhibit a deceptive simplicity that hides a baffling inner complexity; settlement is sparse and, in enormous mining tracts, ephemeral too. Add to emptiness distance—Saharan distance, void of roads, to be traversed painfully on foot, or at best on camels or in Ford cars—and the problem of Western Australia emerges. It is a land of geographical nuance, and yet it divides itself naturally, quite definitely, into a number of clearly marked units with very different destinies before them. These natural regions are of the order of magnitude of American states.

The variety the country displays has not been suspected before the appearance of Clarke's paper. There was a dim public appreciation of the fact that Western Australia is divisible into several parts, but these were associated with the ideas of position and distance, rather than of individuality and unity. We talk, out there, of the Kimberley, the North-West, the Wheat Belt, the Jarrah Belt, and the "Fields," using indeed nearly half of the names that Clarke has bestowed on the natural regions, but using them without any idea of their real significance. Some of them, it seems, are veritable *noms de pays.*

Clarke's paper itself is an admirable piece of work—short, logical, concerned with nothing but the facts, yet stating them as completely and clearly as possible. It is illustrated with a map and a transparency, neither too well drawn but adequate. The regions themselves will most likely stand the test of practical recognition. There may be changes in the positions of the boundary zones, elimination of artificialities and uncertainties as, for instance, the somewhat arbitrary boundary relations between "Perth," "Jarrah," and "Greenough" and there will be an increase of precision in the delimitation of the interior zones. It seems that the broad, natural subdivisions of the state have been indicated as they really exist, though Clarke makes no claim to finality. He offers his scheme as a basis for discussion,

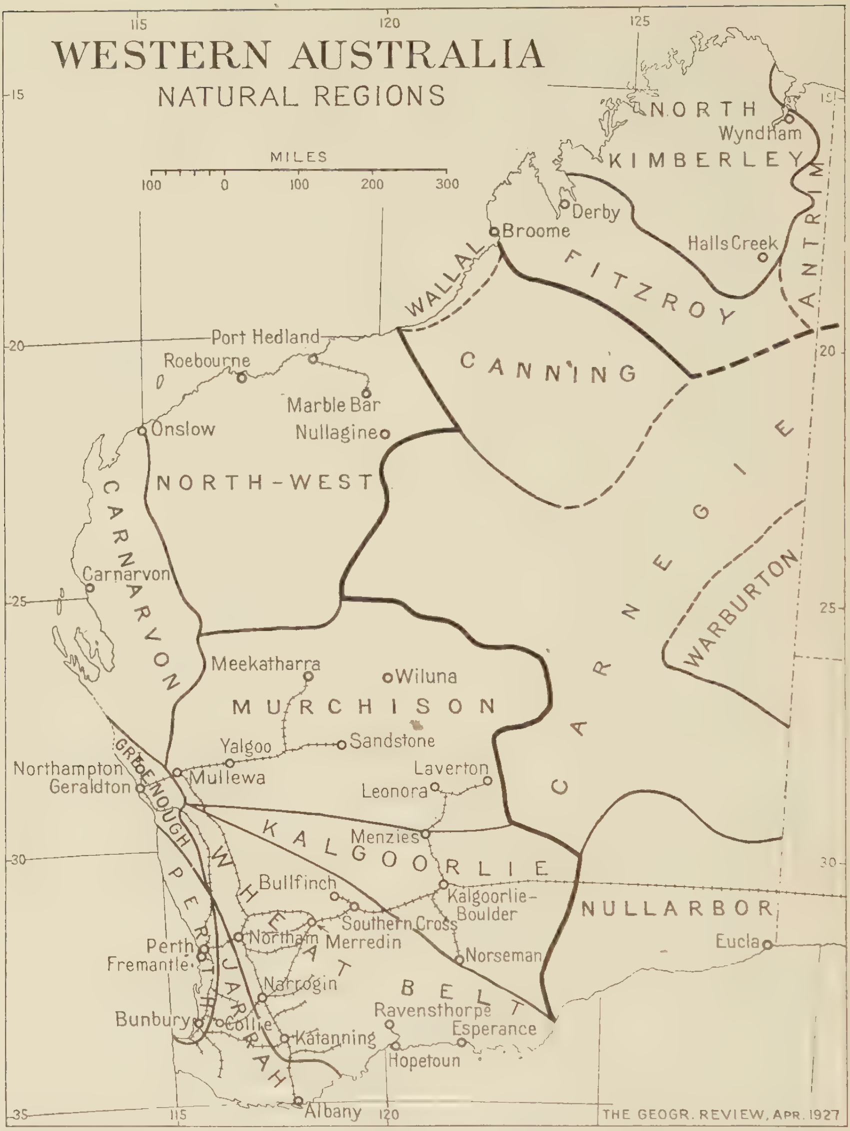


FIG. 1—Natural regions, towns, and railways of Western Australia. Scale of map approximately 1 : 16,500,000. The heavy line delimits the western and northern sections effectively occupied or capable of profitable development under existing conditions

and as such it should be most valuable to the Australasian Association for the Advancement of Science, which has a committee on natural regions.

In the accompanying figure the railways and chief towns have here been superimposed on Clarke's map. A critical examination of the scheme brings out some interesting points. For instance, the eastern margins of "North-West," "Murchison," and "Kalgoorlie" mark the eastern boundary of the effective state of Western Australia, the economic unit that really exists. All east of this line is desertic, until "Warburton" is reached. In the far north is a second group of regions, "Fitzroy," "North Kimberley," and "Antrim," governed from far-away Perth, connected with it only by the coastwise steamer service, and the coastwise aerial mail that has its terminus at Derby—thin lines of connection. This northern group belongs naturally to a tropical unit that extends from here to the north coast of Queensland and which does in fact come under the jurisdiction of a federal commission as part of the new "Development Region North of the 20th Parallel." These two groups of units are connected only by the little coastal subregion of Wallal, occupied by pastoralists, who look to Derby and "Fitzroy" rather than towards "North-West." The political unity of Western Australia falls to pieces before the scheme.

Clarke's regions show, in the very clearest way, those parts of the state that can be profitably developed under existing conditions and those that cannot. "Canning," "Carnegie," and "Nullarbor" might be left to themselves for a generation or two. Meanwhile, to the west of them lies a land that men can use—a subtropical land; and to the north is one that may reward the expenditure of public money—a truly tropical land, very different from the first and linked to it by no natural tie.

Effective Western Australia, region by region, shows some interesting features of detail. Geraldton appears as a town with admirable advantages of position—a natural hinterland in the "Greenough" region, with every region but "North-West" pointing a near corner towards it, a focus of diverse activities from the cattle of "Carnarvon," the sheep of "Murchison," to the wheat and timber of the rainy southwest. One wonders what would happen if the administration were transferred to Geraldton. Would there be an extension of the Northampton railway to Carnarvon? The town, moreover, has independent commercial leanings, having long ago established relations with Singapore perhaps through the sandalwood trade in the first place.

If "Murchison" has a sheep-raising future, will there not eventually be a railway connecting Sandstone with Leonora, and so with Laverton, diverting traffic to the natural channel? The "Wheat Belt" shows its natural capital at Northam, already an important junction of railways and strategically a better place for the state capital than Perth. Kalgoorlie-Boulder looks as if permanence is assured it as the distributing center of the region (the "Fields"), and Menzies and Norseman attract some interest as inter-regional towns. The communications of the "Wheat Belt" converge on Northam, and the belt seems to lack natural outlets. Most of the wheat is shipped from Fremantle. A few years ago it was actually cheaper to send wheat from near Albany to the port of Fremantle. Probably this was due to the power of vested interests. But there seems to be justification for the claims of Esperance as a port. Perth is in the right place for a metropolis: the port of Fremantle dictates its presence, and the weight of population, which will always be towards the rainy southwest corner, ensures its permanence.

A "Secession League" has recently been formed in Perth. It is remarkable that natural conditions isolate the real economic unit of Western Australia from the east far more thoroughly than sentiment. The ribbon of standard-gauge railway from Kalgoorlie to Port Augusta does not "unite" the West and the Eastern States: it only enables them to communicate a little more quickly.

Clarke does not say any of these things in his paper. He merely presents something that is probably real and lets it speak for itself. It is surprising to find that he has not used Griffith Taylor's work, particularly that on rainfall (Griffith Taylor: The Australian Environment, Melbourne, 1918). Taylor was the first to apply the regional conception to Australian geography and the first to use a regional name, "Swanland," which he gave to the rainy southwest corner of the state. The omission, however, has probably done no harm to Clarke's main conclusions, as he is thoroughly informed on the subject of rainfall in Western Australia.

M. Aurousseau

POLAR REGIONS

Two Icelandic Cartographers. Dr. Halldór Hermannsson has contributed as Volume 17 of *Islandica* a study of two Icelandic cartographers of the sixteenth and seventeenth centuries: Bishop Gudbrandur Thorláksson (1542–1627) and his great-grandson Bishop Thórdur Thorláksson (1637–1697). Both of these ecclesiastics were men of superior education. Their attainments not only as map makers but in the broader fields of scholarship give us some idea of the high intellectual standards that prevailed in the Iceland of their time. Bishop Gudbrandur "would have become prominent as a mathematician, if he had cultivated that discipline, for which he had an especial aptitude, instead of turning to theology." His work in geography was noteworthy. He made the first scientific determination of latitude for any place in the island. He constructed a celestial globe and started, but never finished, a terrestrial globe. "In other respects he . . . furthered geographical knowledge by encouraging people to explore unknown or little known parts."

The maps of Iceland which date from before Bishop Gudbrandur's time are very crude, as is evident from the specimens reproduced in Dr. Hermannsson's paper. In 1590 Ortelius published a supplement to his atlas entitled "Additamentum IV theatri orbis terrarum"; in this there was first published a map on which Iceland assumes recognizable, if somewhat distorted, outlines. This map illustrates the common tendency of early cartographers to exaggerate the dimensions of known areas at the expense of the unknown. "Bays and peninsulas are too prominent in comparison with the bulk of the land." A stretch of the southeast coast is much shortened owing to the fact that "this coast is without any harbors, and consequently . . . remained least known of the inhabited parts of the country since it was very seldom visited by outsiders." About 250 names shown on the map establish the Icelandic origin of the original from which it was copied. Although no credit is given, in Ortelius at least, to Gudbrandur, there is little doubt that this map was based on one that the Icelandic bishop had himself drawn, and Dr. Hermannsson is also inclined to believe that Gudbrandur's original was used as a basis for a map of Iceland in Gerhard Mercator's "Atlas" (Duisburg, 1595).

Bishop Thórdur's most important service to scholarship was, perhaps, his publication of the "Islendingabók" of Ari Frodhe of the late eleventh and early twelfth centuries, in which the discovery of Iceland was narrated, of the famous "Landnamabók" containing the account of the discovery of Greenland, and of other "early works of the national literature." Thórdur's academic dissertation, which dealt with the topography of Iceland, though somewhat mediocre in quality, "went through three editions in four years" and was thus doubtless "useful in spreading correct information about Iceland."

Of the three maps of Iceland which Bishop Thórdur drew none was ever published. The first (1668) and third (1670) are preserved in manuscript in Copenhagen and are shown in reduced photographic facsimile in Dr. Hermannsson's booklet. The second map has been lost. The third map Dr. Hermannsson asserts "is quite remarkable for its time, artistically drawn, and often surprisingly accurate in detail. It is to be remembered that no trigonometrical survey of any part of the country had then even been attempted, so the map is based upon a few astronomical observations and calculations drawn from them, upon personal knowledge of doubtless considerable part of the country, upon hearsay and information from various people, and to some extent possibly upon written sources." Although the contour of the coast is somewhat better than on Bishop Gudbrandur's map, the proportions are still inaccurate, and "the interior is very unsatisfactory." No less than 582 names appear on the map.

Certain maps of Bishops Gudbrandur and Thórdur showing Greenland and the northern coasts of the Atlantic are of particular interest in relation to various expeditions that were sent out by the Danish government in the seventeenth and eighteenth centuries in search of the colonies that had been planted in Greenland in the twelfth century, but of which all trace had been lost since early in the fifteenth century. Bishop Gudbrandur's map—a rough sketch—shows the Eastern and Western settlements of the old colony on two fiords penetrating northward into the southern end of Greenland. An inscription asserts that the "whole east coast is entirely uninhabited," and in refutation of Mercator and Magini, "who, following the Zeno story, had presented the northeast extension of Greenland as inhabited," the bishop declares that this "is an absolutely uninhabitable desert." Bishop Thórdur, on the other hand, relying upon certain Dutch cartographers, placed the Eastern settlement on the east coast of Greenland and in so doing confirmed "the fateful error . . . which was the cause of so many futile and disastrous efforts to reach that coast," an error not definitively corrected until the nineteenth century.

Bishop Thórdur's map shows Svalbard, the "cold coast," as an eastward extension of the northeast coast of Greenland, lying due north of Iceland. This is of interest in view of the fact that Spitsbergen and Bear Island were officially given the name of Svalbard when Norwegian sovereignty over Spitsbergen was established in 1925. According to Icelandic annals of the thirteenth century Svalbard was discovered in 1194. Its position as described in the early sailing directions in the introduction to the "Landnamabók" would seem to confirm the position at which Thórdur places it. These and other considerations have led Gustav Holm to identify the Svalbard of the Icelandic sailing directions with the east coast of Greenland in the vicinity of Scoresby Sound. "In the end of the summer the waters off this part of the coast may be entirely free from drift ice, as it presumably was at the time of the discovery. In the sound a rich fauna has been found, consisting of walrus, narwhal and polar bears, all of which animals must have been very valuable for the old Northmen. Consequently, there is every likelihood that the visits were repeated year by year, until the pack ice placed too great obstacles in the way, or the animals decreased in quantity. Afterwards the country was forgotten" (Gustav Holm: "De islandske Kursforskrifters Svalbarde", with English summary, "The 'Svalbarde' of the Icelandic Sailing Directions," *Geogr. Tidsskrift*, Vol. 29, 1926, pp. 3–19; reference on p. 19. See also Finnur Jónsson: "Svalbarde," with English summary, *ibid.*, Vol. 29, 1926, pp. 80–90).

PHYSICAL GEOGRAPHY

A New Delimitation of the Arid Regions. It is well known that an amount of rainfall fully sufficient for successful crop growing in a cool region will be far from adequate when the temperature is high. I suppose twenty inches of rain in a year will grow wheat very well in Montana. But in Arizona it would doubtless need to be supplemented by irrigation water. A large evaporation may leave little water in the ground for plants even if the annual rainfall in itself is considerable. The writer of these lines likes to simplify rainfall maps by delineating only three isohyetals, those for 20, 40, and 80 inches, as separating the four rainfall grades *scanty*, *sufficient*, *abundant*, and *excessive*. The significance of the four adjectives is directed toward *crop growing*, and they should of course be qualified by the added phrase "other things being equal." But other things are not equal, and rainfall is always limited in effectiveness by evaporation which is itself dependent on temperature and amount of sunshine; and sunshine, temperature, and rainfall all interact on one another. Furthermore, any definite quantity of water left in the ground after evaporation has taken its toll from the annual rainfall, is of varying significance for plant growth according to the permeability of the soil and its slopes. In other words the conditions of plant growth are very complex; and rainfall is only one factor, though a very important one.

It appears that Lang (Verwitterung und Bodenbildung als Einführung in die Bodenkunde, Stuttgart, 1920) has proposed a "rain factor" as distinctive for climatic soil types. This rain factor is rainfall in millimeters divided by temperature centigrade. Thus 500 millimeters of rainfall (20″) divided by 10° (50° F.) gives a rain factor of 50.

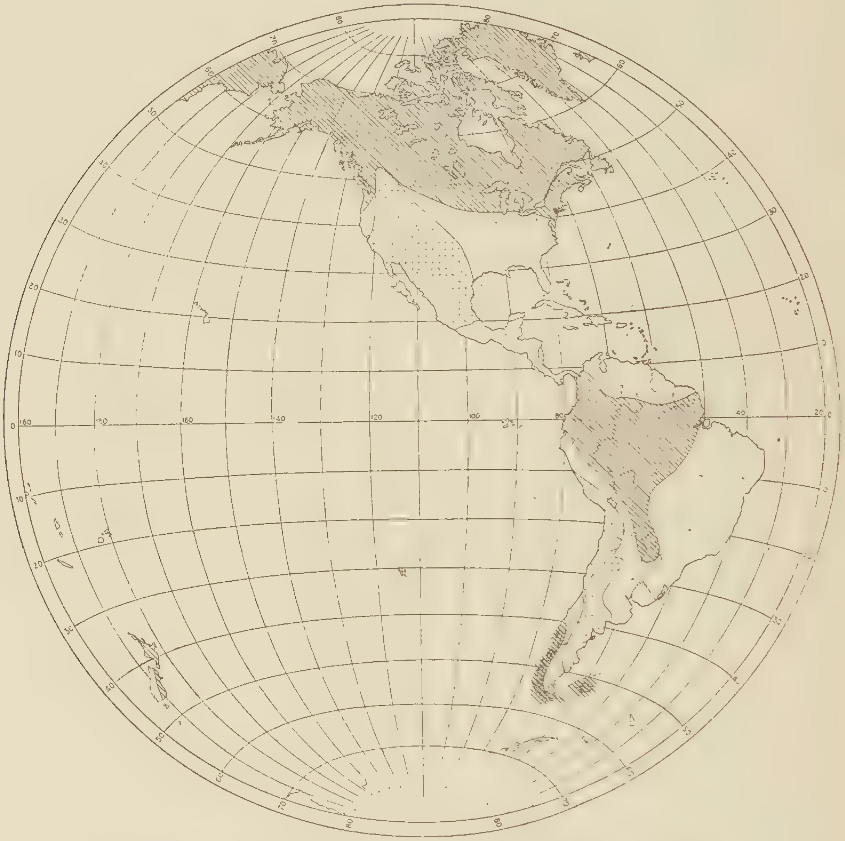
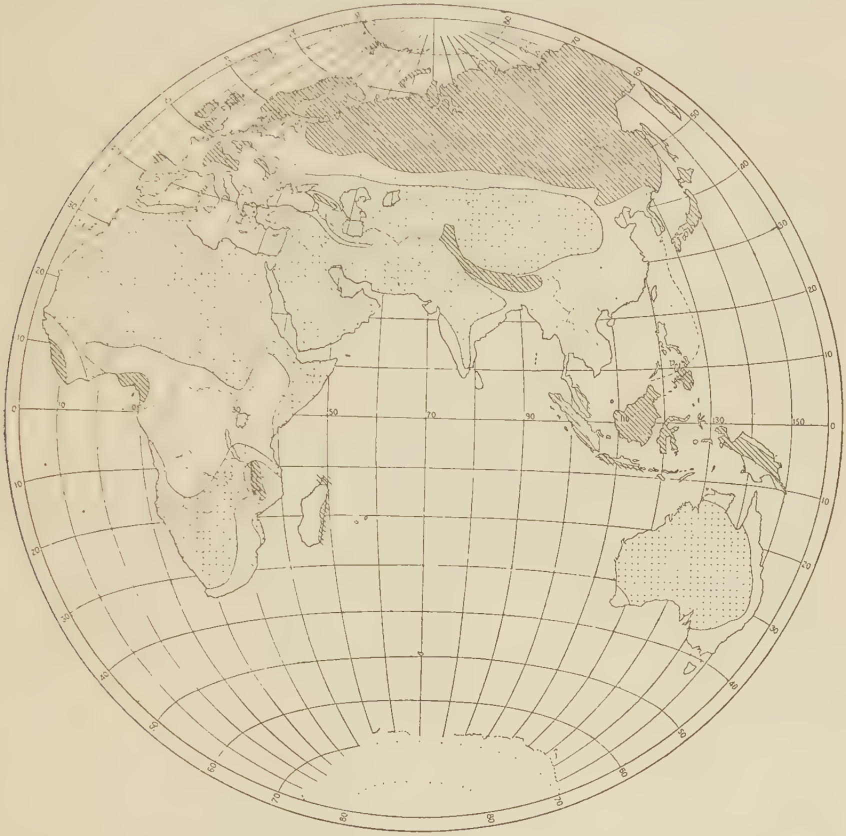


FIG. 1—Isonotides for rain factors of 40 and 100 according to Dr. Hirth. Stippled areas, below 40, are arid; ruled areas, over 100, are "excessively damp."

Dr. Paul Hirth, of Görlitz (Die Isonotiden, *Petermanns Mitt.*, Vol. 72, 1926, pp. 145–149) constructs lines of equal rain factors, calling these lines "isonotides," for the whole world. He says he gets the name from the Greek word νοτίς, meaning dampness (*feuchtigkeit*). Lang made rain-factor grades of 40, 60, 100, and 160. Hirth draws isonotides for 20, 40, 60, and 100. Lang appears to have proved that the critical value of the rain factor to distinguish arid from humid regions was 40. This Hirth accepts, with the modification that the boundary is not a line but a zone of varying breadth, and emphasizes the superiority of this method of delineating the arid regions of the world over a demarcation by rainfall alone (J. I. Adams: Caudal, procedencia y distribución de aguas, etc., *Bol. Cuerpo Ingenieros de Minas del Perú No. 27*, Lima, 1905).

The isonotides for rain factors 40 and 100 are reproduced here. Perhaps they may be said to be the upper and lower limits of dampness suitable for plant growth. If we compare the arid region of these maps having a rain factor under 40, with the area of less than 20 inches (500 millimeters) rain on the annual rainfall map, we note the rain factors in Africa and Australia are very similar to the areas with less than 20 inches of rain, but enlarged to the north and east; while in South America the arid area by isonotides extends less both to south and to north than the area of insufficient rainfall. In North America and Eurasia the arid area by isonotides is smaller than that of insufficient rainfall by large areas between the Pole and latitude about 45° N. The northern parts of Eurasia and North America, inland as well as coastal, are not short of rain for plant needs, although they have less than twenty inches. In the temperate zones the details of isohyetals and isonotides do not differ notably.



Compare this interpretation with the figures on pages 286 and 287 of "A New Map of World Rainfall," by Mark Jefferson, *Geographical Review*, Vol. 16, 1926, pp. 285–290.

The isonotide of 100—here called, perhaps unfairly, of excessive dampness—has some curious features. Not only is Amazonian Brazil overdamp along with Paraguay, Eastern Bolivia, Peru, and most of Ecuador and Colombia, but so are New England, New York, Michigan, Wisconsin, Minnesota, Dakota, western Oregon, and Washington, with all of Canada and Newfoundland, for all these regions have a rain factor in excess of 100. It is hard to see how that can be called an acceptable conclusion. And, as the Amazonian region with rain factor over 100 is about equally divided into one region of seasonal and another of non-seasonal rainfall, it is not periodic rain alone that makes that region unacceptable as an analogue to northeastern United States and Canada.

The problem of availability of rainfall for plant growth is too complicated to be solved by using the quotient of rainfall and temperature. Rainfall matters a good deal, so does temperature; but so also do amount of wind, prevalence of clear sky, slope of the ground, and permeability of the soil; and they all need separate study and expression if we are to arrive at any conception of their united effect, just as in physics we learn the resultant effect of several forces acting together only by considering the effect of each one acting separately.

But it is a great merit of the isonotides that they show graphically that the low temperature of the northern hemisphere north of latitude 45° prevents its small rainfall from leaving it arid.

Mark Jefferson

GEOGRAPHICAL NEWS

Semi-Centenary of Four European Geographical Societies. An interesting contribution to the history of modern geography is given in the proceedings of four European geographical societies which last year celebrated their fiftieth anniversaries—Madrid, Brussels, Antwerp, and Copenhagen. All four societies are under Royal patronage, and celebrations of all were distinguished by attendance of ministers of their respective governments and delegates from other European geographical societies.

The Real Sociedad Geográfica of Madrid held its celebrations on March 25-30. The proceedings are reported in the *Boletín*, Vol. 66, 1926, pp. 145-272, and also in a separate publication, "Quincuagésimo Aniversario, 1876-1926." In addition to social gatherings and excursions including a visit to Toledo, two special public meetings were held at which addresses were given on Spanish contributions to geography. At the meeting of March 25, presided over by the Minister of Public Instruction and Fine Arts, Excmo. D. Eduardo Callejo y de la Cuesta, Sr. D. Antonio López Sánchez spoke on "La Geografía y los Geógrafos españoles en el primer tercio del siglo XIX," Sr. D. Emilio Zurano on "Madoz y su Diccionario Geográfico —Coello y su Atlas de España," Excmo. Sr. D. Luis Palomo on "Los fundadores de la Sociedad Geográfica y de otros Centros é Institutos geográficos."

At the public meeting of March 29 Sr. D. Miguel de Asúa y Campos told of the fifty years' work of the Society; and its President, Excmo. Sr. D. Francisco Bergamín y García, closed with a speech of thanks for the recognition accorded the Society. Señor Bergamín also asked for support for the projects the Society now has under way: the formation of an archive of Spanish geographical photography—a speech on this subject dealing with cinematography was given by Sr. D. Victoriano F. Ascarza—, the publication of a new geographical-statistical dictionary of Spain, and an exhaustive study of the civilizing work of Spain in America.

The twin societies of Brussels and Antwerp held their celebrations in November. Foundation of the Societies was coincident with the famous Geographical Congress convoked by King Leopold II in 1876, and naturally the activities of the Societies have lain largely in the African field. At the special meeting of the Société Royale de Géographie d'Anvers, held on November 6 under the presidency of M. Maurice de Cock, General Gourard, French delegate, spoke on the work of the European countries in Africa in the last half century, and Colonel Sir Francis Younghusband, delegate of the Royal Geographical Society of London, on English colonization in South Africa since 1876, while Colonel Charles Liebrechts sketched in broad lines the great colonial work of King Leopold. The Society issued a richly illustrated commemorative volume which serves as a catalogue to an exhibition of Belgian cartography of the sixteenth, seventeenth, and eighteenth centuries, a fitting memorial for a Society whose seat is a home of early map making, for Ortelius was a native of Antwerp, and Mercator of near-by Rupelmonde (Le cinquantenaire de la Société

Royale de Géographie d'Anvers, *Bull. Soc. Royal Géogr. d'Anvers*, Vol. 46, 1926, pp. 1–5).

The celebrations of the Société Royal Belge de Géographie followed on November 7. M. Charles Pergameni, the President, recounted the history of the Society. Besides encouragement of African studies, the Brussels Society with its sister society of Antwerp helped promote a notable piece of polar exploration in the voyage of the *Belgica* under de Gerlache at the end of last century. Among other speakers were Colonel Sir Francis Younghusband, who described his famous journey to Lhassa, and M. Emm. de Margerie, director of the Geological Service of Alsace Lorraine, who spoke on the work of French geographers during the last hundred years. November 8 also was a "geographical day" devoted to presentation of papers by the following: Charles Pergameni, on the discovery of the Zaïre; A. Halot, on the heroic period of Belgian work in the Congo; J. Vanhulst, on the Congo of today; L. Maury on the cartography of the Congo; H. Seligmann, on the cartography of Belgium; J. Halkin, on geographical education in Belgium; P. Michotte, on type maps of Belgian geographical regions; A. Hegenscheidt, on new programs in geographical instruction. A cartographical exhibition also was held. Mlle. M. A. Lefèvre gives an account of proceedings in the January number of the *Annales de Géographie* and points out in reference to the last named papers the curious situation still obtaining in Belgium that geography is without recognized status as a University subject.

The Kongelige Danske Geografiske Selskap celebrated its jubilee on November 17 and 18. In opening proceedings on November 17 the President, Admiral Wandel, traced Danish geographical activities preceding the foundation of the society, and later Professor M. Vahl spoke on Danish participation in Arctic exploration. At a brilliant function on November 18, attended by H. M. the King and the Royal Family, the Secretary, General de Castonier, gave a résumé of the foundation and history of the Society, and proceedings also included an address by the Chief of Geological Research, M. Victor Madsen, on the "Evolution of Greenland" (*Geogr. Tidsskrift*, Vol. 29, 1926, pp. 193–201).

OBITUARY

Sir John Scott Keltie. Sir John Keltie died in London on January 12 in his 87th year, "at work almost to the last day." Before turning to geography Keltie had engaged in literary and editorial work. This included the subeditorship of *Nature* where he was brought in contact with progressive movements in the scientific world in general. His official connection with the Royal Geographical Society commenced in 1884 by his appointment as geographical inspector to inquire into the conditions of geographical instruction in Great Britain and abroad. His report published in 1886 helped notably towards the improvement of geographical education, as may be seen by comparison with his own review of the situation 35 years later, "The Position of Geography in British Universities" (*Amer. Geogr. Soc. Research Ser. No. 4*, 1921). In 1885 Keltie was appointed librarian of the Royal Geographical Society: in 1892 he became secretary and editor, remaining in this capacity until his resignation in 1915. An interesting record of his term of service is to be found in his address "Thirty Years' Work of the Royal Geographical Society" (*Geogr. Journ.*, Vol. 49, 1917). In concrete form his influence is to be seen in the *Geographical Journal*, which assumed its present form and title in 1893. His services were commemorated by the Victoria Medal in 1917, and among numerous other honors he received the Cullum Medal of the American Geographical Society awarded in 1915.

Keltie's own geographical writings are marked by breadth and humanity of touch as is seen for instance in the little book "Applied Geography" (1890; 2nd edit., 1908). His intimate knowledge of African questions made "The Partition of Africa" (1893; 2nd edit., 1895) a standard work. Doubtless he will be best remembered by the Statesman's Year Book which he has edited since 1883, while he will have a memorial in the help and inspiration he afforded to others out of his store of wisdom.

JOVAN CVIJIĆ. Jovan Cvijić died in Belgrade on January 16 in his sixty-second year. He was a geographer in the fullest sense of the word, with his work distinguished by its comprehensiveness, detail, and originality. In his homeland he found a field little touched geographically, and on every geographical aspect of it he has shed light. On the physical side one may refer to his work on tectonics and glaciology, his writings in western European languages including "Tektonik der Balkanhalbinsel" (Internatl. Geol. Congress at Vienna, 1903), "Grundlinien der Geographie und Geologie von Mazedonien und Altserbien," Vol. 1 (*Petermanns Mitt. Ergänzungsheft No. 162*, 1908), "L'époque glaciaire dans la Péninsule balkanique" (*Ann. de Géogr.*, Vol. 26, 1917). But on this side he is specially known for his definitive studies on karst phenomena. An important paper, "Hydrographie souterraine et évolution morphologique du Karst" (*Recueil des Travaux de l'Inst. de Géogr. Alpine*, Vol. 6, 1918), was discussed in the *Geographical Review*, Vol. 11, 1921, by E. M. Sanders under the title "The Cycle of Erosion in a Karst Region." To the *Geographical Review* he contributed a characteristically careful elaboration of one phase of karst erosion in "The Evolution of Lapiés: A Study in Karst Physiography" (Vol. 14, 1924). Substantial and admirably illustrated is the work "Geomorphologiya" (Morphologie Terrestre) of which two volumes have appeared in 1924 and 1926 respectively and a third is still in manuscript.

Cvijić's intimate knowledge of the Balkans was based on exhaustive field work. He has stated that from 1888 to 1915 he undertook at least one field trip each year in the peninsula aside from journeys in other European regions. In this work he was aided by the students who sat under him since he became professor of geography at the University of Belgrade in 1893. With their collaboration he has published through the Serbian Academy of Sciences a series of volumes—20 have appeared up to date—on the population of the Serbian lands, largely a study of the migrations of the southern Slavs and their consequences. His writings in human geography also include the papers "The Geographical Distribution of the Balkan Peoples" and "The Zones of Civilization of the Balkan Peninsula" in the *Geographical Review*, Vol. 5, 1918, and that excellent regional monograph, "La Péninsule Balkanique" (Paris, 1918).

Professor Cvijić also was responsible for the foundation in 1910 of the Geographical Society of Belgrade and the inception of its bulletin, now an annual publication whose contents may be found analyzed in the *Bibliographie Géographique*. The esteem in which Cvijić was held as teacher and scholar is reflected in the "Recueil de Travaux" offered by his friends and collaborators on the celebration of his 35 years of scientific work in 1924. He was awarded the Cullum Medal of the American Geographical Society in 1924.

GEOGRAPHICAL REVIEWS

Studies in Eskimo Culture and Origins

Knud Rasmussen. **Across Arctic America: Narrative of the Fifth Thule Expedition.** xx and 388 pp.; maps, ills. G. P. Putnam's Sons, New York and London, 1927. Price $5.00. 9½ x 6½ inches.

"And in my heart I bless the fortune which made me be born in a time when Arctic exploration by means of dog sledging was not yet antiquated."

This was Knud Rasmussen's first outburst of gratitude after having gloriously reached his goal, no doubt the first man who has made the voyage directly from Greenland across the ice-filled Hudson Bay and from there on dog sledge to Bering Strait and the coast of Asia—having thus perambulated, Eskimo fashion, the Arctic shores between the northernmost corners of the Atlantic and the Pacific Oceans. A stretch which our time has royally transformed to a flying passage of some few days and nights: but Dr. Knud Rasmussen spent three years on it. He aimed at something other than making discoveries in the air or flying high over his objects of investigation. His work was meant to be built not on one dimension but on all; and as one of them we must reckon time.

Let it be said at once that Dr. Knud Rasmussen has succeeded, in coöperation with his Danish scientific associates—K. Birket-Smith, Therkel Mathiassen, Peter Freuchen, and others—in producing a number of new contributions to the geography, archeology, anthropology, and folklore of the Eskimos and their lands. Thus he has augmented our knowledge of the central Eskimo tribes, their history and distribution, their culture and mentality. He reached some of them in time before the white man's shadow could fall on the national culture of the tribes by way of trading or mission work. Here south of the North Magnetic Pole a virgin soil was still left for the white explorers; here the innermost kernel of the Eskimo race was found, the tribes of the Barren Grounds and the archipelago north of Hudson Bay. These tribes had maintained their old bow-and-arrow and stone-age culture up to our own days.

I do not mean to say that this expedition has discovered the primeval Eskimos or solved the problem of the origin of the Eskimo culture. This is what Dr. Rasmussen believes himself, because he thinks he has discovered among these people so many proofs of the theory (already formed by earlier ethnologists) that the Eskimos originated from certain Indian tribes of the interior, who have emigrated to the Arctic coasts west of Hudson Bay. Here they are assumed to have transformed "the winter side" of their hunting culture into seal hunting on the sea ice or from the kayak. Our (Danish) countryman H. P. Steensby in 1920, in his first paper, bestowed much learning and phantasy in support of this theory but later on he modified it essentially in the English edition. In contradistinction to Steensby I am of opinion that the earlier theory of Alaska as the place of origin of the Eskimo culture, advanced by J. H. Rink about 1868, is nearer to the truth. But I think that the problem ought to be viewed at a wider angle so that the correspondences with the Arctic peoples of Siberia and various East Asiatic peoples could be taken into consideration before the whole question is solved.

As a result of the archeological explorations Dr. Rasmussen's expedition seems to have unveiled the riddle of the fabulous people, the Tunit of the legends, who lived in stone houses in the central parts. He has finally discovered who they were and where their descendants live now: they turn out to be identical with the ancestors of the Thule culture who long ago peopled the archipelago north of Canada and whose descendants still people the coasts of Greenland and probably also the northern coasts of Alaska. Dr. Rasmussen is inclined to see in both of these groups offshoots from the primeval Eskimos of the Barren Grounds, so that he considers the Alaskan Eskimo culture as a secondarily developed coast culture which, finally, sent a secondary, or tertiary, offshoot back from Alaska eastward right over to Greenland.

The newest and most valuable material in Dr. Rasmussen's book is derived from the deep sources of Eskimo life. From the last untouched tribes, he brings us many vivid and intimate pictures of their day-by-day pursuits, of their conceptions of the world, and of their moral and traditional ideas. I believe that this book will become one of the primary sources of our knowledge of the Eskimos. Owing to the author's vigorous understanding and intimate insight into the primitive mind of this people it is superior, in certain respects, to most of the earlier works on this theme. I do not mean to disparage the works of the American ethnologists, many of which testify to a more scientific method; but let it be remembered that this book of Dr. Knud Rasmussen is merely a preliminary report of his voyage without any aim at systematization. E. W. Nelson has produced the principal classic work on the Alaskan Eskimos, and the recent works of the Canadian Arctic Expedition on the west central Eskimos surely rival both those of Professor Franz Boas and of the Danish Greenland experts. It is a question if the investigations of Knud Rasmussen's expedition will prove to be productive on the same points as those of the American ethnologists. I have especially in mind here Nelson's descriptions of the culture festivals, masks, and ideas and Jenness' monographs on Eskimo music and cat's cradles and his notations of Eskimo texts. But Knud Rasmussen and his comrades excel by their immediate understanding of the language and in their method of research work, because they have first trained themselves through many years of study in Copenhagen and in Greenland. It is to be hoped that the Danish school of Eskimo study, founded in the last century by men like Dr. Rink and G. Holm, will assert itself when the new and in part foreign material from Eskimo regions outside of Greenland comes to be dealt with.

William Thalbitzer

Waldemar Bogoras. **Early Migrations of the Eskimo Between Asia and America.** Bibliogr. *Compte-Rendu Congrès Internat'l des Américanistes, 21st Session, 2nd Part, at Göteborg, 1924,* pp. 216–235. Göteborg Museum, 1925.

This interesting paper, by the author of the volume on the Chukchi in the Memoirs of the Jesup North Pacific Expedition, deals with two subjects rather closely interwoven. In the first part the writer gives some new information concerning the number and village sites of the Asiatic Eskimos, their dialects, and their relations with the neighboring Siberian tribes; in the second he tries to show that their main dialect, Ai'wan, contains more archaic features than any other Eskimo dialect, and suggests, in rather guarded language, that the Asiatic shore of Bering Sea may have been the original homeland of the entire Eskimo stock. For the most part the paper is an excellent one; only the theoretical portion lays itself open to serious criticism.

The Asiatic Eskimo, it is said, number about 1000, a figure derived from a census taken 25 years ago; and they are scattered through nine villages, seven on the south side of Indian Point and two on the north side of East Cape. Bogoras' analysis of place names, strengthened by some archeological evidence, shows that they occupied a much longer stretch of the coast in former times but were driven out by the Chukchi. He believes that they are now increasing, although epidemics such as he witnessed in 1896 and 1900 may wipe out the surplus of a decade.

Bogoras asserts that St. Lawrence Island was colonized from the Asiatic, not from the American side. This is probably true; but it is no longer true that the population of the island is rapidly dying out and is kept up only by immigration from the mainland of Asia. The United States government keeps a large reindeer herd there under the general supervision of a school-teacher, and the inhabitants are now fairly prosperous. I understand, indeed, that they are really increasing in number, although exact figures are not available to me at this moment.

The presence of three distinct dialects among the Asiatic Eskimos, as described by Bogoras, indicates conditions parallel to those on the Alaskan side. Bogoras gives many examples in his paper of the great influence the Chukchi and the Asiatic Eskimos have exerted on each other, affecting not only the material cultures of both peoples but their languages. The Eskimos borrowed many words relating to land animals and land pursuits, the Chukchi an even larger number relating to sea mammals and maritime activities; and both peoples borrowed each other's conjunctions. The Chukchi strangely enough, show no disposition to learn any foreign language. When a party of Chukchi came to trade at Little Diomede Island last summer they brought as their interpreter an East Cape Eskimo who had learned their language. Their leader, however, had a slight smattering of English, and, since nearly all the trade goods come directly from America, it is probable that English rather than Chukchi or even Russian will become the *lingua franca* for all the native tribes along this coast.

In South Alaska the rôle of the Chukchi was filled by the Athapaskan Indians, from whom the Eskimos borrowed many elements of their material culture and of their social and religious life. The interaction in language here is less clear but has probably been considerable. On both sides of Bering Sea, therefore, the Eskimos have undergone much greater pressure from outside peoples than anywhere between Bering Strait and Greenland.

This has a significant bearing on an important section of Bogoras' paper, his theory that the Ai'wan dialect of Asia is the most archaic of all the Eskimo dialects. Here he is at a distinct disadvantage, because no good lexical material has yet been published from Alaskan tribes, and he is forced to depend on the imperfect studies of Schultze and Barnum. It seems premature to assert, therefore, that many words in the Ai'wan dialect are known in Labrador or Greenland but unknown in Alaska; the instance he gives, Ai'wan *amak*, "wolf," Greenland and Baffin Land *amaroq*, is actually widely known in Alaska; I have recorded it in the Greenland form at Barrow and Point Hope in the north, at Wales in Bering Strait, and at Inglestat in Norton Sound. Some of the supposedly archaic features in the Ai'wan dialect, again, may rather be degradations due to the dropping of initial and final sounds, such as I have noticed in the dialect of East Cape. The Ai'wan dialect may possibly contain some archaic elements not found in other places, but, judging from the material presented in this paper, it rather appears to have undergone greater modification than any dialect outside of southern Alaska. After all, this is what we should expect in view of the overwhelming influence exerted by the Chukchi and the Yukon Indians on the Eskimos of this area.

Bogoras raises the question as to whether the Eskimos were aboriginal in Asia and thence went over to America, or whether they first developed in America and later migrated back into Asia. Without committing himself to a definite answer, he emphasizes the antiquity of their occupation of the Asiatic shore and suggests that the archaic (?) character of the dialects there constitutes a strong though not conclusive argument in favor of an Asiatic origin. So he speaks of a human wave starting at Bering Strait and reaching Greenland only a few centuries before the present date and states that he is ready to assume that some eight to ten centuries ago the Eskimo tribe formed a whole which was moving from the west eastward. In proceeding to occupy new territories in the east, he adds, they naturally had to leave the countries in the west; so they retreated before the pressure of their western neighbors, among whom the Chukchi were the most prominent. He suggests, further, that the retreat of the Eskimos from Asia was perhaps correlative with their occupation of Greenland; that the Arctic villages left by the Eskimos to the maritime Chukchi were compensated for by the new Greenland settlements, including those captured from the Norsemen.

Here Bogoras seems to overlook or minimize the importance of recent discoveries in northeastern America and to allow too little time for the growth of the various Eskimo cultures in the eastern Arctic. It is highly improbable that the Eskimos inland from Hudson Bay, who never hunt sea mammals or visit the sea except to trade, migrated from Alaska within the last 800 or 1000 years and abandoned their ancient culture in favor of a new and more primitive mode of life. Again, the old Thule culture of Hudson Bay and northwest Greenland, whatever its place of origin, was certainly well established in those regions before the Icelandic discovery of Greenland. It is fairly certain, too, that the Skraelings, whom the old Norsemen encountered in "Vinland," were Eskimos, and it is hard to believe that they could have traveled so far from Bering Strait in one or two centuries. Finally the Eskimo settlements in the Arctic are so scattered and extend over so vast a stretch of coast line that even a violent disturbance of the population on the Asiatic shore could hardly cause, except very remotely and then only after the lapse of many centuries, so great a movement in northeastern America as the migrations to Greenland.

D. JENNESS

EXPLORATION IN ARABIA

R. E. CHEESMAN. **In Unknown Arabia.** xx and 447 pp.; maps, ills., index. Macmillan & Co., London, 1926. 25s. 10 x 6½ inches.

Well within the margin of the great desert of southern Arabia lies the oasis of Jabrin. Although mentioned by medieval Arabic geographers and shown on many modern maps as a broad well-watered wādi running eastward to the Persian Gulf, Jabrin before 1924 "had been denied to European eyes, and had been seen even by very few Arabs. Its palm groves had been surrounded by a veil of mystery and many were the tales of wonder and magic told by the superstitious badawin who graze their camels in the vicinity." Major Cheesman's journey has swept away the mystery. We know now that the well at Jabrin with "unlimited water at 40 feet" lies in latitude 23° 18′ 6″ N., longitude 48° 54′ 10″ E., and we also know that the Jabrin oasis, far from being a great, wide, fertile wadi, is a small tract of "neglected palm groves with bare limestone spaces and shallow water holes." A few Bedouins of the Āl Murra tribe dwell here in an "encampment of black and white wool-woven tents." Having come recently under the control of Ibn Sa'ūd, who is trying to foster in the nomads of his realm a taste for agriculture and more civilized ways of living, the Āl Murra at the time of Cheesman's visit were "attempting to grow a few small patches of young wheat," irrigating their meager fields by means of primitive water hoists operated by donkeys.

Major Cheesman came to Jabrin on a course running a little west of south from Hufūf through waterless sandy and gravelly plains fringing the dunes of the Jāfūra desert to the east. His journey, undertaken primarily for the purpose of collecting zoölogical specimens, was made possible by Ibn Sa'ūd. Before plunging into the unknown south, Cheesman was obliged to spend several months in the capital of Al-Hasa, during which he occupied himself in collecting specimens. His informal, humorous story of experiences in Hufūf gives an entertaining picture of everyday life in one of the largest and most prosperous settlements of Arabia.

Hufūf owes its prosperity to an abundant water supply. There are probably several hundred running springs in the Hasa oasis, many of them thermal. Use of the water for irrigation, as is almost universally the case in arid regions, is strictly controlled by the community. "When a man buys a garden he obtains a paper on which his times for water are noted, and this paper is left with the Governor. . . . The system of control that has been evolved by custom has now developed into a marvelously complicated and efficient piece of machinery."

Besides writing of his journey to Jabrin Cheesman devotes a chapter to an expedition carried out in 1921. Hearing that there were ruins at Salwa, lying at the head of the shallow, narrow gulf separating the peninsula of Qatar from the mainland, he undertook a journey thither, in the course of which the first survey of the gulf of Salwa was made. The ruins proved disappointing, but Cheesman found a recompense for his disappointment in 1923 when he discovered an extensive field of ruins near 'Oqair, the port of Hufūf. There is strong reason to believe that these represent the remains of the great ancient emporium of Gerra.

In the zoölogical field Major Cheesman not only collected many specimens, including some of new species, but made not a few valuable observations on adaptations of animal life to the desert environment. Unlike Dr. P. A. Buxton (see *Geogr. Rev.*, Vol. 15, 1925, pp. 170–172), he is a believer in protective coloration: "I think the development of a colour as evidenced most clearly in a subspecies is the result of an influence which I will call the subspecific desire, operating through generations of that species, for that particular tone which will harmonize with its environment and render the wearer inconspicuous."

Owing to the fact that the desert is occasionally visited by fogs and that its surface is not infrequently covered with a heavy dew, Cheesman finds it difficult "to advance any theory as to whether the various species seen are able to exist entirely without water or not." Stories of camels going very long periods without drinking "are mostly derived from imaginative badawin by over-credulous travellers." The maximum period during which the camel can withstand thirst is probably not very much more than twelve days.

Cheesman points out that "the sands were the nomad's best grazing grounds and were not the lifeless wastes I had imagined" (see also the present number of the *Review*, pp. 205–206). "In the dune country the plants were larger and in far greater variety" than in the gravel plains, the reason for this being that "the sand has the power of absorbing and retaining dew and, of course, rain if it occurs, while the gravel has not."

THE COUNTESS MALMIGNATI. **Through Inner Deserts to Medina.** 188 pp.; map, ills. Philip Allan & Co., London, 1925. 10s. 6d. 9 x 6 inches.

The authoress professes to have made an extensive journey from Palmyra through the deserts of northern Arabia to Zilfi, thence to Medina, and thence returning by the Hejaz railway back to Damascus. Her book is illustrated with photographs and drawings.

She asserts that her trip was facilitated by "Sultan Al Tayar," Prince of the "Roalla" tribe; the head chief of the Rwala since 1906, however, has been An-Nûri eben Sha'lān. My young friend Sulṭān âl Tayyār, who is not a member of the Rwala but of a subdivision of the Weld 'Ali, camps almost the whole year round in the vicinity of 'Adhra, not far from Damascus, and never leads his tribesmen to central Arabia. The Rwala would never camp near Palmyra in June nor migrate in high summer in the unreasonable manner described by the authoress. The camping grounds of the 'Amārat are on the banks of the middle Euphrates, not east of Medina where she states she has met this tribe. Since 1842 there have been no *kaymākams*, or Turkish governors, in the settlements of Nejd, although the Countess Malmignati writes of having encountered one in every town there. The manners and customs of the Bedouins and settlers as she describes them are ridiculous.

The authoress does not mention the year of her expedition. In 1908–1909 and again in 1914–1915 the undersigned lived many months with the Rwala and Shammar in the regions that the Countess pretends to have crossed. At the time of my sojourn in Arabia, however, she was unknown both in the desert and at Damascus. From 1916 to 1919 Medina was besieged, and it would have been impossible to enter it as she pretends to have done. Since 1919 the railway between Medina and Damascus has been in operation very seldom. It is not possible, therefore, to assign any date for the Countess's trip.

The photographs and sketches contradict the narrative. There are two photographs (at pages 46 and 68) both said to represent the rich merchant "Mahmoud Bassaam," who the Countess says accompanied her on her journey. The illustration at page 46, it is true, is a portrait of my friend Muhammad eben Bassām, a millionaire residing at as-Sāleḥijje—but he never accompanied any European into the inner deserts. The person in the illustration at page 68 is a different man, Dāūd an-Nebki, also an acquaintance of mine. The figure at page 62 according to the legend represents the author's tent and caravan at Palmyra. As all the camels in this photograph carry pack saddles and are lying before a peddler's tent and the huts with the mountains behind them resemble the huts of 'Adhra with the mountain chain overlooking it, I suspect that the camels are the same as those in the photograph at page 84 and that they represent pack camels carrying cotton from Dāūd an-Nebki's farm to Damascus and photographed at the mosque of 'Adhra. In the drawing at page 132 entitled "On the March" the Countess and her companions are riding on pack saddles! In this as well as in the figure at page 78 Prince Sultan and his horse riders are carrying *bunduqiyye* rifles, whereas in reality they would be ashamed to be seen with such antiquated weapons. The figure at page 142, said to represent Arabs from Zilfi, is a photograph taken near the Roman vault at 'Adhra; the tomb of the saint belongs in the field southwest of the village and not in the vicinity of Zilfi where the Wahhabites long since would have destroyed it. The figures at page 168 were taken in the vicinity of Sūq Wādi Barāda, west of Damascus, and have nothing to do with the village of Hanakiyah, east of Medina. Furthermore, no Bedouin woman would ever dress in the manner in which the authoress appears in the frontispiece.

These and many other details which might readily be cited show us that the book in part at least is palpably fictitious and that it is probably based wholly on observations made by the authoress in the immediate vicinity of Damascus supplemented by a none too ingenious imagination.

Alois Musil

The Great Barrier Reef of Australia

J. P. Thomson and Charles Hedley, edits. **Reports of the Great Barrier Reef Committee.** Vol. 1, xii and 175 pp.; maps, diagrs., ills., bibliogr., index. *Trans. Royal Geogr. Soc. of Australasia* (*Queensland*), Vol. 1, 1924 (Special Ser.), 1925. 10s. 9½ x 6 inches.

At the suggestion of the Royal Geographical Society of Australasia, centered at Brisbane, Queensland, the scientific societies of the Commonwealth have organized a large committee "to investigate the origin, growth and natural resources of the Great Barrier Reef." With a length of about 1000 miles and an enclosed lagoon from 20 to 70 miles in width, the Great Barrier Reef is the largest coral reef in the world. At the time of writing a letter received from Sir Matthew Nathan, Hon. Chairman of Barrier Reef Committee, states that the boring through Oyster cay, some 20 miles from Cairns, has been carried down, largely through loose stuff, for 450 feet without the foundation rock being reached and is being continued.

The field of study has been wisely defined as including the Queensland coast as well as the reef and its lagoon. Charles Hedley of the Australian Museum at Sydney [whose death unfortunately occurred on Sept. 14 last] was appointed as full-time scientific director, and a new serial, the *Transactions of the Royal Geographical*

Society of Australasia (*Queensland*), established at Brisbane, to publish the results of investigation as they are reported. The first volume of the *Transactions* was issued in 1925 and contains 16 articles, mostly rather brief.

The leading article is "A Geological Reconnaissance in North Queensland" by Professor H. C. Richards, vice chairman and secretary of the committee, and Mr. Charles Hedley. It is not very penetrating with regard to the main problem, namely, the foundation of the barrier reef, which indeed can hardly be reached in a preliminary study. And in some respects the paper is unconvincing. Thus, the statement concerning two sandstone islands of gently anticlinal structure between the islands in the lagoon: "Consideration of the shore lines on both sides [of the channel] suggests that the sandstone mass has opened out or cracked roughly along the axis of the anticline, for the peninsulas on the one side fit into the bays on the other side. It would strike a lay observer that some unusual disruptive force had been in operation here. There would no doubt be a series of minor cracks at right angles to the main crack along the axis, and the disposition of the bays on either side of the channel are no doubt governed by these cross fractures." A lay observer would be a very poor adviser in such a problem; and it may surely be questioned whether cross cracks would account so well for the infitting of peninsulas and bays—an infitting which an outline map shows not to be very precise—so well as the drowning of a slightly sinuous anticlinal valley, eroded previous to the submergence.

A paper on "The Natural Destruction of a Coral Reef," by Hedley, records the effect of a heavy rain in 1922—55 inches were measured at a near-by station—in killing one of the shore fringes of which Saville Kent gives fine plates in his famous and magnificently illustrated work on the Great Barrier. A report by the same observer on the Townsville plain, apparently a worn-down area of weak rocks—"a readjustment to a new base level consequent on a large subsidence"—is in part more interrogative than affirmative: "What forecast is there whether the earth movements so energetically performed in the ante-penultimate cycle will continue, augment, decrease, or cease? It is suggested that these movements originate in the sinking of the floor of the Carpenter Deep. For its area this deep is already profound. If that depth has now reached equilibrium, a period of stability for the shore may be due. But if the Carpenter Deep shall continue to sink from great to greater depths, then the coast may be racked to correspond." An evident alternative is that then the coast may continue a very tranquil subsidence.

Lieutenant W. E. J. Paradice contributes a descriptive paper on the coral pinnacles that rise, tower-like, in the quiet lagoon waters back of the main reef; and in connection with this paper is the frontispiece, an airplane photograph of an isolated reef from a height of 10,000 feet; the reef and the shoal in its rear stand out with a white rim of surf foam from the black of the deeper water.

Several papers on the physiographic evolution of certain coastal areas are contributed by F. Jardine, science research scholar of the University of Sydney, in which various river changes appear to be well worked out; but the bearing of these changes on the origin of the Barrier Reef is not made clear; the effect of a small volcano of recent eruption in diverting the course of a river—truly, a good item, but only of local interest, and already described by Daneš 14 years ago—is given unnecessary prominence. A serviceable map of the coast, the lagoon, and the reef closes the volume.

W. M. Davis

Climate of Quaternary Times in Mexico

Fritz Jaeger. **Forschungen über das diluviale Klima in Mexiko.** viii and 64 pp.; maps, diagrs., ills. *Petermanns Mitt. Ergänzungsheft No. 190*, 1926.

The Basin of Mexico and the region to the north were in Pliocene and Pleistocene time occupied by a large fresh-water lake. On Ixtaccihuatl the snow line lay at least 800 to 900 meters lower, and the glaciers extended fully 1180 meters below their modern termini. The climate of the Mexico basin, now arid, was consequently then humid; but whether this was due to heavier rainfall or decreased evaporation on account of the lower temperature has not been determined. So far only one high-water stage has been found recorded. On climatological grounds it is believed that the highest water stand coincided with the maximum glaciation in the mountains. However, at least the highest water stand was perhaps not fully contemporaneous with the climax of the glaciation under higher latitudes; it may rather have corresponded in time to the early ice retreat (Ernst Antevs: The Big Trees As a Climatic Measure, *Carnegie Instn. Publ. No. 352*, 1925, pp. 60 and 74). Jaeger points out that various supposed evidences for changes of the humidity on the equatorial border of the arid belts in Africa are fictitious and that the once greater moisture in this belt in Mexico need not have had correspondence elsewhere.

Ernst Antevs

The Tides for the General Reader

H. A. Marmer. **The Tide.** xi and 282 pp.; maps, diagrs., ills., index. D. Appleton & Co., New York and London, 1926. $2.50. 8½ x 5½ inches.

The phenomena of tides are so marked and their effects so important in the industrial life of a country that a really satisfactory book on the subject is to be welcomed. It is not an easy matter to write about tides; for the subject has many difficulties, and considerable restraint is necessary. As Mr. Marmer points out, it is as difficult to disprove some of the theories offered by sundry would-be exponents of the subject as it is to disprove the statement that "the moon is made of green cheese." We know very little about the tides in the main oceans, and consequently our knowledge of the propagation of tides has been acquired chiefly by considering the coastal phenomena: in fact, we have truly touched only the fringe of the subject.

Such knowledge as we possess concerning oceanic tides is largely based upon difficult mathematical researches. Consequently Mr. Marmer, when he touches on these matters, frequently falls back upon the authority of the mathematicians; perhaps some readers might consider him over-cautious in this; but when one has had to read some of the "explanations" offered annually by non-scientific—or, more precisely, by non-mathematical—writers one cannot blame him for excess of caution. The external forces are very accurately known, and Mr. Marmer deals with these forces and the response of the tide. He then deduces some of the principal characteristics that may be found in the tide *at some place or other*, and consequently when such are noticed we can refer them back to the original cause. Where most writers come to grief is in the attempt to trace all the intermediate stages; thus much has been made of the wave theory of tides, it being supposed that the tides are largely generated in the great belt of water encircling Antarctica and that all other tides are offshoots of these. Such a theory has been severely criticized, and it would not be upheld today by any informed writer. Mr. Marmer refers to these theories, of course, and to others, especially to those put forward by the late Dr. Harris, of the Coast and Geodetic Survey. Undoubtedly these latter theories have helped us to get onto right lines even if the detailed applications are not generally accepted. Thus Mr. Marmer wisely omits the charts of "cotidal lines," but in view of recent work, it is to be regretted that he did not include a specimen chart for one of the regions for which the tidal régime is substantially known.

We do not wish to leave the impression that the tidal motion out at sea is the principal source of interest in tides. The phenomena in bays and rivers, the relation of current to elevation, the effects of wind and barometric pressure are all of very great interest and importance, especially as many of these are capable of accurate explanation. Many legitimate explanations are furnished in the book, and simple calculations are given wherever it is not necessary to put the onus on the mathematician. A special chapter is devoted to the flood and ebb in New York Harbor, being chiefly the account of Mr. Marmer's own researches; this chapter will probably interest the specialist rather than the general reader, because of the great detail, but the general reader will be interested in the chapter on the greatest tide in the world. Of course it was necessary to say something about tidal power, and the author gives a brief summary of a recent English book. A chapter is devoted to the effects of tidal friction on the motion of the moon; but it is regretted that "the mathematician" in general is credited with the estimates of tidal friction, whereas our knowledge is due almost entirely to the work of Taylor and Jeffreys.

The methods whereby tides are predicted are considered in three chapters dealing respectively with Tide Tables, Harmonic Analysis, and Harmonic Prediction. There seems to be a fatality about the diagram of operation of a tide-predicting machine, and the author is in good company when his curve has only half the range indicated by the crank! However, these chapters are well written and are based upon the personal experience of the author as a member of a national organization concerned with the production of tide tables.

The book is well printed, with only one serious blemish due to the interchange of two or three lines on p. 168. It is commended as the most comprehensive book in the English language for the general reader interested in the tides, and it is noteworthy for accuracy as well as for lucidity.

A. T. Doodson

Ptolemy's Geography

Otto Cuntz. **Die Geographie des Ptolemaeus: Galliae, Germania, Raetia, Noricum, Pannoniae, Illyricum, Italia.** v and 225 pp.; maps, indexes. Weidmannsche Buchhandlung, Berlin, 1923.

Ptolemy, the last of the great Greek geographers, worked at Canopus near Alexandria in the first half of the second century of our era. His "Geography," as is well known, exerted much influence on the progress of geographical science in later antiquity and during the Middle Ages, especially among the Moslems. With the rediscovery of Greek in the early Renaissance its influence became felt in Western Europe, where the "Geography" was very popular until the discovery of America and the circumnavigation of Africa ushered in newer conceptions.

Much of the importance of Ptolemy's work was due to its form rather than to its originality. Though it was one of the greatest attempts in antiquity to systematize geographical knowledge, an analysis of its contents has shown that the "Geography" is nothing more than an industrious compilation. The text, apart from the introductory sections of Book I and the concluding ones of Book VIII, is a mere list of places arranged according to their latitudes and longitudes, the plan of the author excluding all descriptive matter beyond a few short references. The "Geography" is obviously the work of a scientist more interested in astronomy than in geography.

The impressive tables of geographical coördinates, however, gave to the "Geography" a scientific appearance. But modern scholars have made it increasingly evident that this scientific character is only apparent; not only are towns and groups of towns wrongly placed and frontiers distorted, but, in a word, most of the latitudes and longitudes were never scientifically computed at all. It has been shown that the latitudes of only seven places in Egypt were known, and Egypt had long been the home of geography. As in the supposed case of Marinus of Tyre, upon whose work that of Ptolemy was to a large extent based, the latter's whole imposing catalog has long been thought to have been erected on imperfect estimates from existing Roman *Itineraria*, or road routes, and *Peripli*, or sailing routes. This explains Ptolemy's ill repute today and the fact that scholars use him only with the utmost care where his data are unique and neglect him where other material is available.

Only in the last few years have serious attempts been made to prove the inference of Ptolemy's method in detail, and until that of Dr. Cuntz, under review, none of these have yielded comprehensive results.

For the purpose of his investigation, Dr. Cuntz chose that part of the "Geography" which covers an important section of the Roman Empire about which both Ptolemy and the *Itineraria* were especially full—Italy, the four Gauls, and the Danube lands Raetia (and Vindelicia), Noricum, and the two Pannonias as far as Viminacium and the Save. His chief results appear in the convenient form of an alphabetic map commentary in the concluding chapter. With this as a base, a rectified Greek text of the sections chosen was constructed, accompanied by a critical apparatus and shorter commentary. In another chapter Dr. Cuntz compares location data found astronomically—a few of which Ptolemy gives, but without distinguishing them from the rest—with those found in the *Itineraria*, thereby discovering that Ptolemy used several centers—Rome, Mediolanum, Aquileia, etc., ten in all—from which distances were reckoned and that these distances agree each time with the *Itineraria*.

Cuntz's results may be said to be definitive. What others had assumed in respect to Ptolemy's indebtedness to the *Itineraria* or had proved in a few cases, Dr. Cuntz has proved for a large part of Ptolemy's work and thereby has disclosed the method followed by the geographer throughout.

Walter Woodburn Hyde

The Smoke Problem

Napier Shaw and J. S. Owens. **The Smoke Problem of Great Cities.** xvi and 301 pp.; diagrs., ills., index. Constable & Co., Ltd., London, 1925. 22s. 6d. 9 x 6 inches.

J. B. Cohen and A. G. Ruston. **Smoke: A Study of Town Air.** New enlarged edit. xii and 108 pp.; map, diagrs., ills., index. Edward Arnold & Co., London, 1925. 8s. 6d. 8½ x 5½ inches.

"Public opinion has often been vocal after a day of black darkness, but only a few enthusiasts regard the making of no smoke as a duty which they owe to the community irrespective of legal penalties." There is a slight Hibernicism in "the making of no smoke," but we heartily agree with the authors of "The Smoke Problem of Great Cities" that "making smoke" and polluting the air is an offense against man and nature.

They tell us that during an ordinary clear day in London there are in a cubic centimeter of atmosphere 300 solid particles; and on a foggy day 40,000 such particles. The difference is due to smoke. It is interesting to know that Royal Proclamations prohibiting the use of coal were disregarded as far back as 1307. It is said that one man who disobeyed the king's command was tried, condemned to death, and executed for burning sea coal in London.

The chapter on the Natural Ventilation of Great Cities throws a flood of light upon the formation of "decks" or "lids" represented by inversion layers, that is stratification when temperature increases with height. On an ordinary day the lapse rate of temperature is about 1 degree centigrade for every 200 meters; but during inversions it is warmer aloft, and the chilled surface air remains at the bottom. Now it is under such conditions, associated with stagnant anticyclonic circulation that London, Paris, and New York experience their worst fogs. The smoke from chimneys, especially house chimneys, is trapped and held in this bottom "lid" or layer. Our authors say "there is no chance for the smoke to reach 500 meters where the wind very seldom fails; it is all kept down easily within the level of a little more than the top of St. Paul's and we get a concentrated mixture of air and smoke."

There is another type of fog the explanation of which we have not previously seen. In winter over London there are two conflicting air currents—a cold stream from the east, called Continental, and a warm stream from the west, the Atlantic. The westerly current turns north and goes to Spitsbergen. The easterly current divides, one part turning north and running side by side with the westerly, making two streams with marked difference in temperature. Another part turns south, and so there is a triangular patch of dead air, so to speak. This gives a cloud zone at some height, which makes a gloomy day, but different from the smoke fog condition.

Two dwellers in a smoky city, Leeds, are joint authors of the serviceable little book "Smoke: A Study of Town Air." Both have long studied the problem of smoke control in manufacturing cities and towns. They tell us that as one passes out from the center of Leeds the solid impurities in the air are decreased 50 per cent at the distance of one mile, 84 per cent at 2.5 miles, and 95 per cent at 3 miles. Evidently, then, there is a great waste of unburnt coal within a short distance.

The book deals mostly with various analyses of the soot tar in town and city atmospheres. At Hunslet, in Leeds, 281 tons of insoluble matter are carried down by the rain or otherwise deposited on each square mile each year; and two per cent of this is tar. At Central Birmingham 483 tons, at Glasgow 210, at London 263, at Newcastle 404, at Rochdale 542 are thus deposited. Much, however, depends upon the location of the collecting gauges with respect to wind. Factory furnaces produce soot that has less tar than that from chimneys of dwelling houses. The combustion is better, and so there is more ash.

The latest and most detailed studies on the effect of soot on vegetation are given. Soot blocks up the stomata, impedes transpiration, limits the assimilation of carbon dioxide, and because of its acidity has a more or less corrosive effect. Among plants, conifers seem to be the most sensitive to injury from soot deposits. There are excellent photographic reproductions of the rings of growth of a Scotch fir that clearly show how growth was checked by smoke contamination and acid fumes due to the building and operation of a factory near by.

Alexander McAdie

Yearbooks of the South Swedish Geographical Society

Sydsvenska Geografiska Sällskapet Årsbok. 1925; Årsbok. 1926. [Vol. 1], 1925, 247 pp.; maps, ills., bibliogr.; [Vol. 2], 1926, 244 pp., maps, ill., bibliogr. Gleerupska Universitetsbokhandeln, Lund, 1925 and 1926. 9½ x 6½ inches.

The South-Swedish Geographical Society was founded on May 16, 1925, on the initiative of Professor Helge Nelson of Lund. Its chief object is a wider dissemination of geographical knowledge in general and about Sweden in particular. The Society publishes a yearbook edited by Professor Nelson, the first two volumes of which have appeared. The first volume contains 11 articles, including studies of the physical and human geography of Southern Sweden, Swedish settlements in North America, the pre-Columbian history of the Maya Indians, terrace cultivation in the Mediterranean region, etc. The six articles of the second volume deal with the agricultural regions of Scania, pastoral life in an area of northern Sweden, peat investigations in Scania, movements of peoples and frontiers in the Balkan Peninsula and in western Asia, the Peninsula of Yucatan, and the irrigated regions of the earth. The volumes also give lists of Swedish geographic literature for the years 1924 and 1925. The articles are richly illustrated with good photographs and excellent maps.

The usefulness of the volumes is much reduced by the fact that they are published exclusively in a little-known language. It would be to the advantage of all, if peoples writing in any other language than English, German, or French realized the necessity of giving at least adequate résumés in one of the languages mentioned.

Ernst Antevs

CORRESPONDENCE

London School of Economics and Political Science
London, England, December 11, 1926

To the Editor of the *Geographical Review:*

I have read with much pleasure Mr. Ellsworth Huntington's kind and appreciative review of my book "The Dravidian Element in Indian Culture" (*Geogr. Rev.*, Vol. 16, 1926, pp. 680–681).

I should like to take this opportunity of pointing out that since its publication my main contention has been unexpectedly and conclusively proved by the explorations at Harappa and Mohenj-Daro (in the Scinde and Punjab) proving the existence in India of pre-Aryan cities of high civilisation and of the very closest affinity with the Sumerian culture of B. C. 3500.

As Mr. Huntington refers specially to my speculations with regard to the origin of the Brahman caste, and of its authoritative status, I should like to add that Dr. Pargiter's recent book "Ancient Indian Historical Tradition" contains a thorough examination of the information available in Sanscrit literature on this subject. He shows (p. 305) that the earliest Brahmans were non-Aryan, that they were rather wizards and medicine men than priests (p. 308), but held very high rank, equal to princes, and after the Aryan invasion intermarriages took place on a considerable scale between these Dravidian Brahmans and families of Aryan chieftains; and thus great and powerful Brahman families were established, gradually dropping magical pretensions and becoming a priestly caste.

Yours faithfully,
Gilbert Slater

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The American Geographical Society is the oldest geographical society in the United States. When it was founded, in 1852, there were but twelve similar societies in the world. Now it exchanges publications with more than four hundred scientific associations. The Society publishes the *Geographical Review*, a quarterly magazine issued in January, April, July, and October, and a *Research Series* of comprehensive scope. It has also a large and growing library—one of the most important geographical libraries of the world; thousands of maps and charts; and a remarkable collection of atlases of the sixteenth, seventeenth and eighteenth centuries.

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Miss Semple has written extensively on the influence of geographic environment on man. Her "Influences of Geographic Environment" (1911) is a standard exposition of the subject in English. Her "American History and Its Geographic Conditions" (1903) is also widely known. She has made a special study of the geography of the Mediterranean in classical times. Miss Semple has contributed several papers to the *Geographical Review* and its predecessor, the *Bulletin of the American Geographical Society.*

Mr. Klimm is instructor in geography at the Wharton School of Finance and Commerce of the University of Pennsylvania.

M. de Martonne, professor of geography at the Sorbonne, is one of the foremost geographers of France. An idea of his varied geographical activities may be gained from "Geography in France," which he prepared for the American Geographical Society as its *Research Series No. 4a* (1924). These activities include secretaryship of the Association de Géographes Français, which publishes the "Bibliographie Géographique," and of the Comité National de Géographie and he is one of the editors of the *Annales de Géographie.* Professor de Martonne's bent is especially towards physical geography, in which field he has written a standard work "Traité de géographie physique," now in its fourth edition. He has also interested himself in the study of several regions, including the Carpathian lands and the regions of France.

Dr. Zierer is assistant professor of geography at the University of California at Los Angeles.

Mr. Batschelet is geographer on the Bureau of the Census, Washington, D. C.

Mr. Van Cleef is professor of geography at the Ohio State University. He has specialized mainly in climatology and the application of geography to business. He has also taken a particular interest in Finland and the Finnish people. He revisited that country and other Baltic States last year for the purpose of geographical study. His several contributions to the Society's journal include "The Finn in America" (*Geogr. Rev.*, September, 1918).

Mr. Heck is chief of the Division of Terrestrial Magnetism and Seismology, U. S. Coast and Geodetic Survey. He is the author of numerous Survey publications on wire drag work, submarine acoustics, and various phases of magnetism and seismology.

Professor Brown is head of the department of geography of the Rhode Island College of Education at Providence. He has made waterways a special field of study (see his "Our Waterway Requirements," *Geogr. Rev.*, February, 1918), devoting particular attention to the Mississippi River, whose physical geography and whose function as a pathway of commerce he has discussed in numerous papers, mainly in the *Bulletin of the American Geographical Society.* He is the author of "The Geography of Worcester, Mass." and other studies in city geography and he has also made many contributions to educational geography.

Dr. Longwell is assistant professor of geology in Yale University. He is especially interested in problems of structural geology, his field work therein being done largely in southern Nevada. To the *Geographical Review* he has contributed "Geological Significance of Isostasy and Gravity Measurements: A Review" (January, 1925).

Dr. Nunn, of Berkeley, California, is a student of early cartography. He is the author of "The Geographical Conceptions of Columbus: A Critical Consideration of Four Problems," the Society's *Research Series No. 14.*

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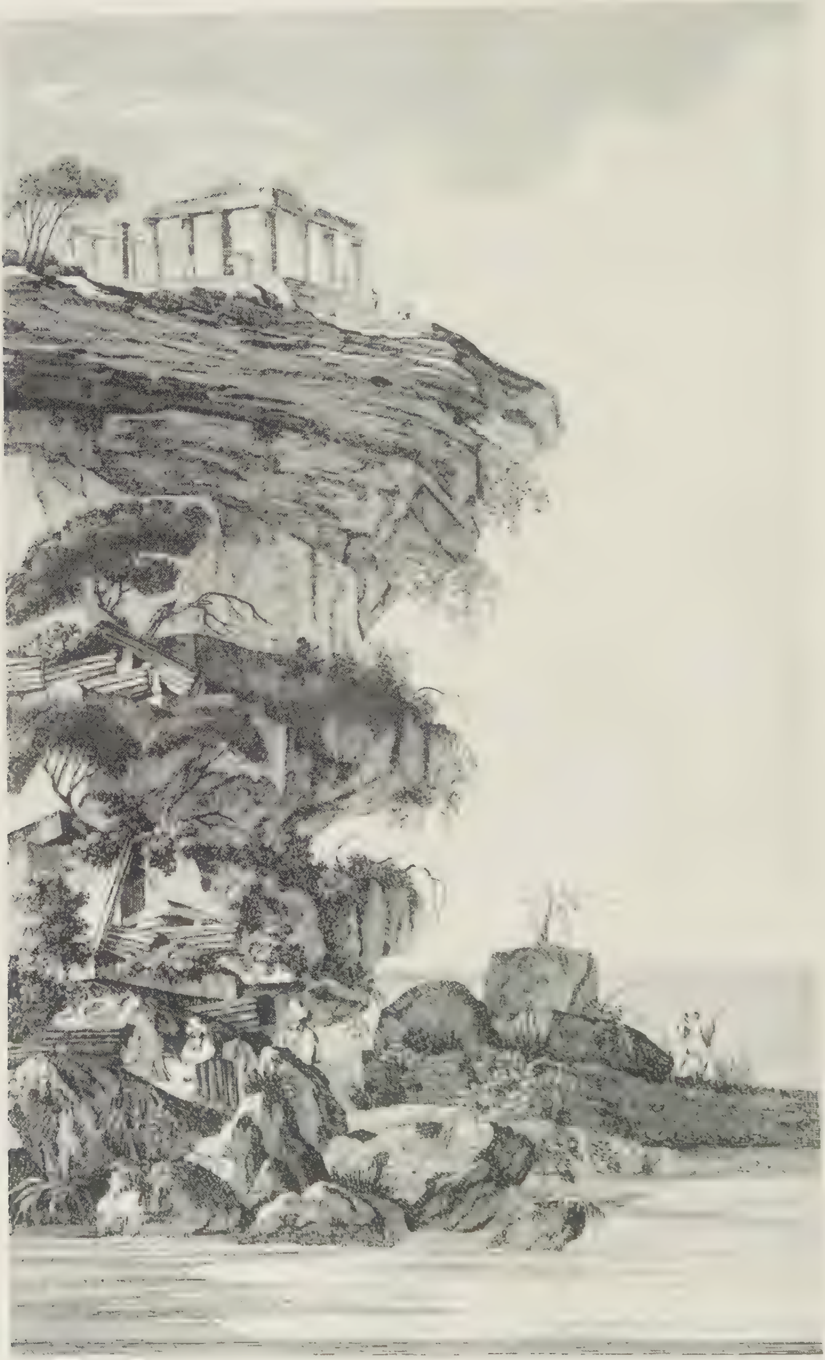

FIG. 1—The Poseidon temple on Cape Sunium (Cape Colonna). (From J. B. Lechevalier: Recueil des cartes, plans, vues et médailles, pour servir au voyage de la Troade, Paris, 1802.)

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THE TEMPLED PROMONTORIES OF THE ANCIENT MEDITERRANEAN*

Ellen Churchill Semple

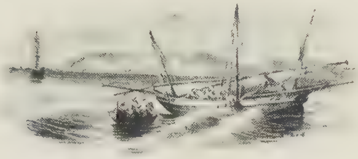

FIG. 2—Cape Taenarum.

THE traveler who crosses the Aegean Sea from Smyrna to Athens is greeted at the threshold of Greece with a vision of ancient Hellenic beauty. As he rounds the bold promontory of Sunium, which marks the tip of the Attic peninsula, he beholds far up above him the temple of Poseidon crowning the headland, outlined against a sky blue as the cloak of the Madonna. Below it the cliffs of white crystalline limestone drop sheer for two hundred feet down to a cobalt sea, whose waves are fretted into lace as they break upon the rocks. Above, the white marble temple gleams in the early morning sunshine, posed between blue and blue. It is an arresting vision. No signs of life are near, except where a half-deserted cove, exposed to the fury of the southwest winds, receives an occasional boat or fisherman's smack. Why was the temple placed there? A location so striking seemed to indicate a compelling reason. One surmised that it might be either the welcome home for the returning fleet or merchantman of ancient days or a pious expression of thanks for a safe voyage which stirred in the hearts of the Attic sailors. But this reason seemed inadequate. Therefore one was moved to question

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* Read before the twenty-third annual meeting of the Association of American Geographers at Philadelphia, December 28-30, 1926.

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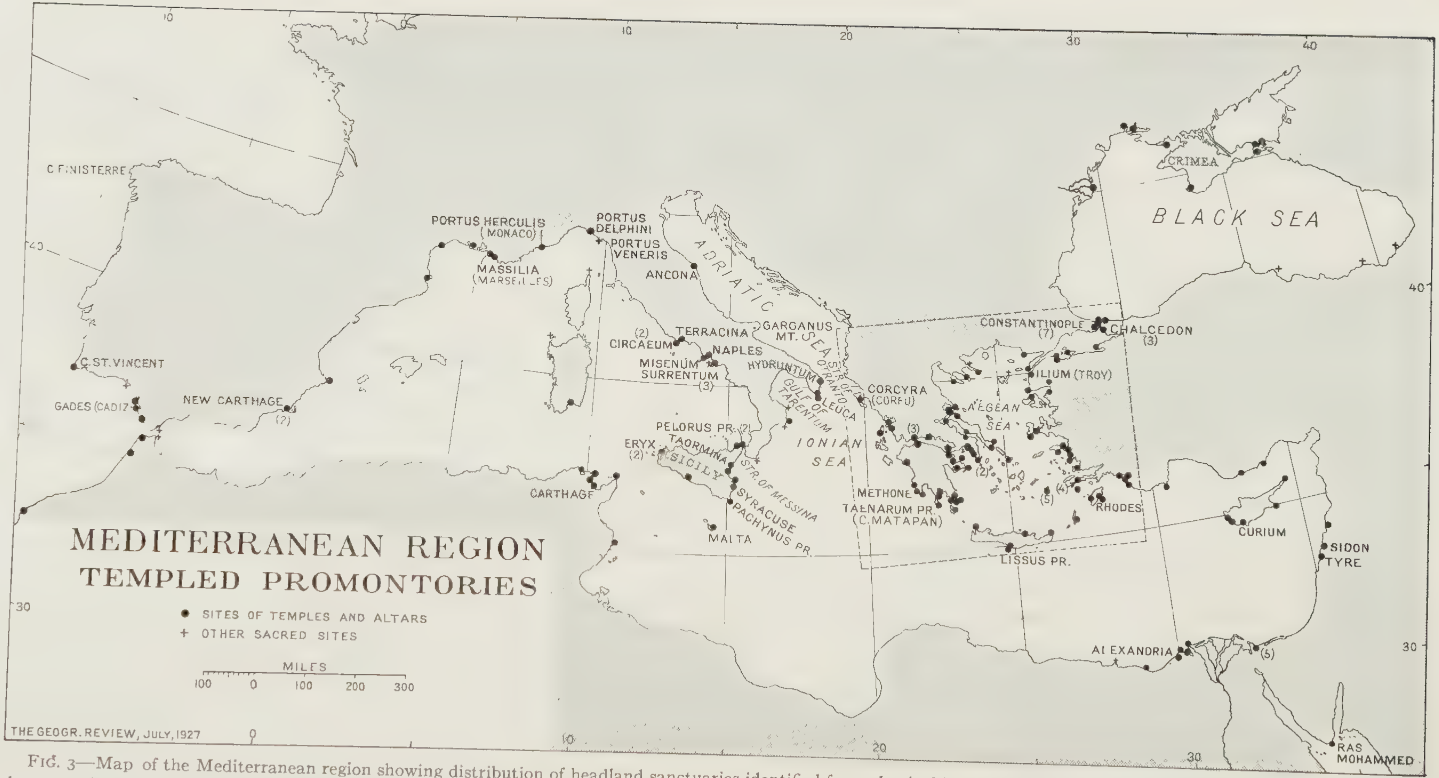

FIG. 3—Map of the Mediterranean region showing distribution of headland sanctuaries identified from classical literature. The dots show sites where altars or temples are known to have existed. Crosses show headlands regarded as sacred but lacking record of altar or temple. See Figure 4 for an enlarged map of the Aegean area. Scale of map, 1:25,000,000.

Use was made of the following authorities: Aeschylus, Anyte, Apollonius Rhodius, Appian, Archilochus, Aristophanes, Aristotle, Athenaeus, Catullus, Cicero, Diodorus Siculus, Euripides, Herodotus, Hesiod, Homer, Homeric Hymns, Horace, Josephus, Juvenal, Livy, Lucan, Macrobius, Ovid, Pausanias, Philostratus, Pliny the Elder, Plutarch, Polybius, Pomponius Mela, Procopius, Propertius, Ptolemy, Scylax, Seneca, Sophocles, Strabo, Suetonius, Tacitus, Thucydides, Vergil, Vitruvius, Xenophon.

whether there were other temples crowning other promontories on the busy sea lanes of the ancient Mediterranean. Moreover, out of the days of one's early Latinity, out of the murk of dative case and subjunctive mood, there loomed faint memories of temples along the southern promontories of Italy mentioned in the Aeneid, shrines to Athene and Hera and Castor and Pollux, those patron saints of ancient seamen.

The next move was to search the Mediterranean shores for these headland sanctuaries by throwing out a dragnet over all classical literature for the evidence, drawing in the facts from Homer and from Procopius, from Juvenal and from Livy. This research extended over fourteen years and is still incomplete. However, it assembled sufficient material to furnish a basis for some geographical conclusions. The investigation yielded one hundred and seventy-five of these promontory shrines, besides over a dozen consecrated headlands, known to the ancients as sacred but lacking any surviving record of altar or temple. Numerous other cases, not here included, rested upon suggestive but incomplete evidence.

Distribution of Promontory Temples

These sanctuaries were found to be distributed from the tip of the Sinai peninsula in the Red Sea,[1] a notorious spot for conflicting winds and currents dreaded by Greek and Roman seamen, all the way west to the angle of Portugal at Cape Finisterre, where a rude cairn of stones marked the consecrated worship of an ancient Melkart or Heracles.[2] They reached also from the Crimean Bosporus, where they clustered thick along the sea ways leading to the Scythian grainfields, south to Egypt and west to the headland of the Pyrenees,[3] where these mountains stretch out the rocky skeleton of an arm before they dive beneath the waves of the Mediterranean.

From the accumulated data it became possible to formulate certain generalizations as to the distribution of these headland sanctuaries, and even to conjecture their former sites while the facts were still unknown. Given certain winds and currents at certain promontories, a summit shrine or altar was almost inevitable, and nine times out of ten it was eventually located. For instance, the port of Ancona on the northeast coast of Italy, sheltered from the bora by a rocky cape of elbow form, is mentioned by Livy and Procopius as chief Adriatic naval base of the Romans. Search for nearer details about Ancona led through the poems of Catullus and the satires of Juvenal[4] and established the fact of a temple to the marine Aphrodite, built by the original Syracusan colonists to their tutelary deity. Local tradition in Ancona places the site of this temple on the tip of Monte Guasco promontory, whence the cathedral of Saint Ciriaco now overlooks the town (Fig. 5); but Peruzzi states that the ruins of the ancient temple, together with the extremity of Monte Guasco itself, fell into the Adriatic during an earthquake in 558 A. D.[5]

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[1] Strabo, *Geography*, XVI, 4 : 18.

[2] Strabo, *op. cit.*, III, 1 : 4.

[3] *Ibid.*, IV, 1 : 3.

[4] Catullus, 36, 13 : Juvenal, IV, 40.

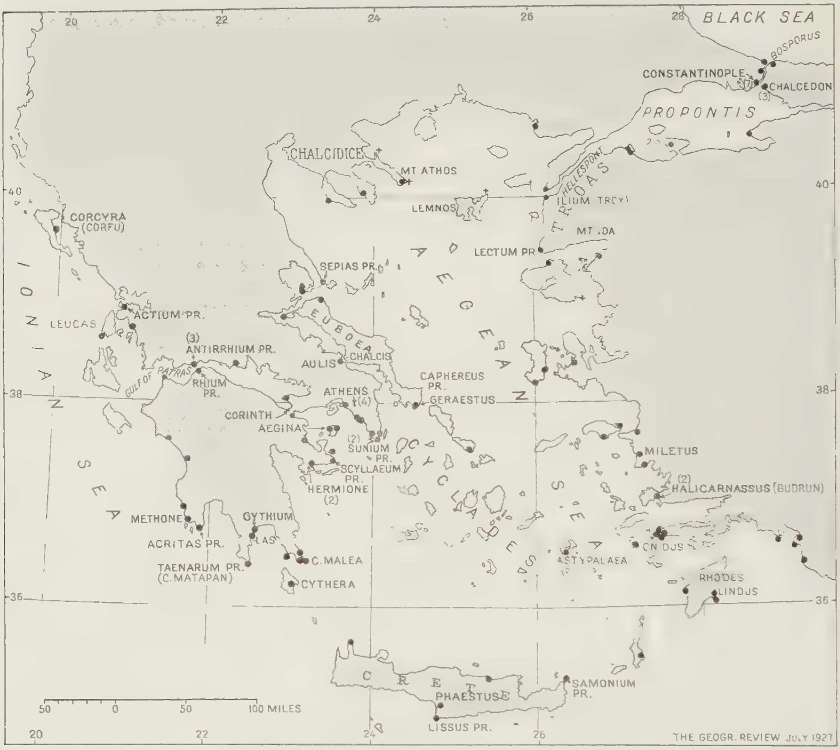

FIG. 4—Sacred headlands of the Aegean area. See the explanation accompanying Figure 3. Scale of map, 1:7,500,000.

FORMS OF HEADLAND SANCTUARIES AND THEIR ANTIQUITY

The form of these headland sanctuaries was varied. One type was the imposing Doric temple to Poseidon on the Sunium promontory (Figs. 1 and 7), or the rich fane of Venus of Eryx on the northwest angle which Sicily thrusts forward into the Tyrrhenian Sea.[6] A simpler form was the sacred grove with its shrine or marble canopy over the statue of the god, like the sacred precinct of Artemis on the northeast promontory of Euboea.[7] Most primitive was the wave-wrought cave which nature provided as a local shelter for altar or wooden image of the deity.[8] Pausanias mentions a cave with an image of Poseidon on Cape Taenarum. On the limestone walls of such grottoes grateful prayers have been found, inscribed by ancient seamen saved from shipwreck near the stormy headlands.

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[5] F. Hamilton Jackson: The Shores of the Adriatic: The Italian Side, London, 1906, p. 225.

[6] Polybius, *Histories*, I, 55; Diodorus Siculus, *Bibliotheca historica*, IV, 83.

[7] Herodotus, *Histories*, VII, 176; Plutarch, *Life of Themistocles*, VIII.

Most of these headland sanctuaries date back to the gray dawn of history. They were ascribed by the ancients to legendary builders of various races, like Orion, Daedalus, Heracles, Jason and the Argonauts, Cadmus, Danaus and his daughters, Neleus, Ulysses, Agamemnon, and Aeneas. The Tyrian Heracles, or Melkart, sea Baal of Phoenicia, had a large number to his credit. Many of the famous temples of historical times, like that of Sunium, Eryx, and the Lacinium cape (Capo Colonne) of southern Italy, were erected on the foundations of far earlier sanctuaries.[9] The original temple of Apollo Branchidae, or Didymus, crowning the Milesian promontory of the Ionian coast, antedated the Ionian immigration and the founding of Miletus.[10] The temple of Artemis on the Lindus promontory of Rhodes was also pre-Hellenic.[11]

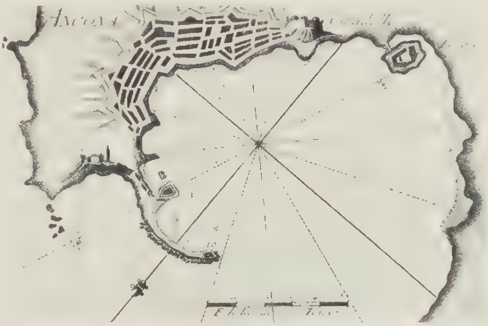

FIG. 5—The harbor of Ancona showing the cathedral of San Ciriaco on Monte Guasco on the site of which local tradition places a temple of Venus. (From Pl. 78 of "Recueil de 155 des principaux plans des ports et rades de la Mediterranée" . . . . , Genoa, 1801.)

In some cases a succession of deities were enthroned on these promontories. Maritime traders, colonists or oversea invaders brought their new gods and grafted them upon local divinities already established on the sacred headlands. The primitive sea goddesses Dictynna and Britomartis of Minoan Crete left their names and legends attached to certain rocky capes of the island,[12] but they themselves merged more or less into Artemis of the Doric invaders; later in the composite form of Dictynna Artemis they were transplanted in turn to various promontories of Greece and the Cyclades Islands.[13] In all cases the new incumbents succeeded to the site and its appropriate office, for all performed the divine function of protecting seamen.

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[8] Pausanias, *Description of Greece*, III, 25 : 4.

[9] M. P. Nilsson: Griechische Feste von religiöser Bedeutung, Leipzig, 1906, p. 63; E. A. Freeman: The History of Sicily, from the Earliest Times (4 vols., Oxford, 1891), Vol. 1, pp. 199–209.

[10] Pausanias, *op. cit.*, VII, 2, 3.

[11] Diodorus Siculus, *op. cit.*, V, 58; Herodotus, *op. cit.*, II, 182.

[12] Herodotus, *op. cit.*, III, 59; Strabo, *op. cit.*, X, 4 : 12–14.

[13] Pauly-Wissowa: Real-Encyclopädie der classischen Altertumswissenschaft, article "Diktynna."

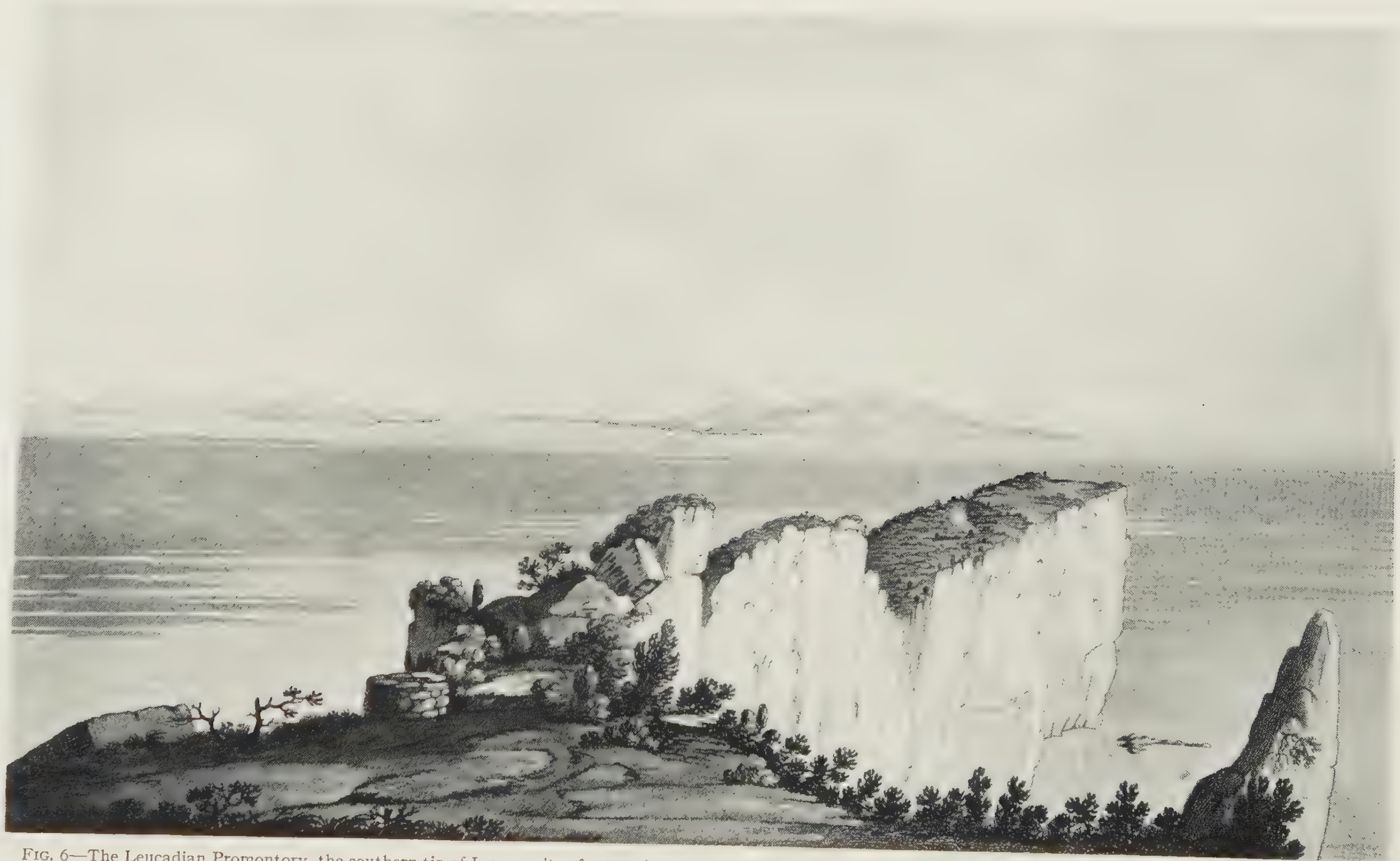

FIG. 6—The Leucadian Promontory, the southern tip of Leucas, site of a temple of Apollo. In the left background, Ithaca, to the right Cephallonia. (From William Gell: The Geography and Antiquities of Ithaca, London, 1807.)

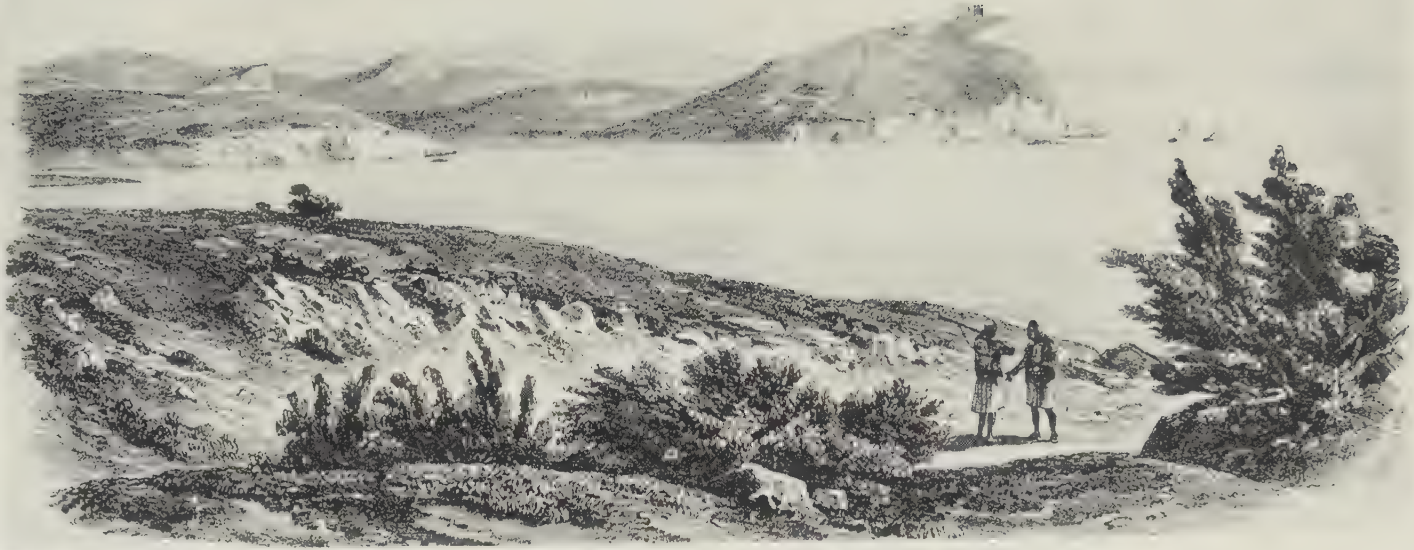

FIG. 7—Cape Sunium and its temple. (From O. M. Baron de Stackelberg: La Grèce, Vues pittoresques et topographiques, Paris, 1834, Vol. 2.)

Winds and Currents

The importance of these promontories to ancient seamen is apparent in all classical literature. For the coastwise navigation of ancient and medieval times, when no compass directed the timid sailor, these headlands were sea marks for the groping prows of Greece and the adventurous sails of Tyre, for the beaked boat of the pirate as it nosed its way along the trail of the prey. The high relief of the Mediterranean coasts made the headlands conspicuous during the four summer months that formed the season of navigation, for then no fog or mist blurred their outlines. But their high relief also converted the straits and bays enclosed by them into sea canyons, through which the winds swept with restless violence in July and August when the northern air currents, the etesians of the Greeks whose marked regularity was noted by Hesiod,[14] reached their maximum strength. In June and September, when the prevailing winds shifted from north to south or from south to north, these headlands were points of conflicting gales and raging surf. They were known to the ancient seamen as places of severe storms, especially the wind storms of the Mediterranean summer. The poet Archilochus, who wrote in 700 B. C., gives us the picture:

Behold, my Glaucus, how the deep
Heaves, while sweeping billows howl,
And round the promontory steep
The big black clouds portentous scowl.

Many of these promontories were notorious, like Cape Malea, whence Jason, Ulysses, Menelaus, and countless other mariners were swept by the violent north wind south past Cythera and Crete to the African coast, hundreds of miles from their projected course.[15] The reputation of Malea was embodied in an ancient adage of Greek sailors, "If you pass beyond Malea, forget your home." Equally notorious was Mt. Athos, which capped the long eastern prong of the Chalcidice peninsula with a marble mass 6350 feet high. It was a seamark for all navigators in the northern Aegean, visible for long distances. At the summer solstice at sunset it cast a shadow fifty miles across the Aegean to the island of Lemnos and made early twilight in the market place of Myrina.[16] Thus it was a guide to seamen but also a terror. On its rocky base the Persian fleet in 490 B. C. was dashed to pieces by the northeast wind;[17] therefore Xerxes ten years later cut a canal across the base of the peninsula, that his fleet might pass in safety.[18] The headlands of Sicily and Italy which abut upon the Strait of

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[14] For a meteorological description see J. S. Paraskévopoulos: The Etesiens, *Monthly Weather Rev.*, Vol. 50, 1922, pp. 417–422.

[15] Homer, *Odyssey*, III, 287; IV, 514; IX, 79–83; Herodotus, *op. cit.*, IV, 179.

[16] Apollonius of Rhodes, *Argonautica*, I, 601–606.

[17] Herodotus, *op. cit.*, VI, 44, 95.

[18] *Ibid.*, VII, 22, 23.

Messina converted the local tidal currents into a whirlpool, whose perils were embodied by the ancients in the monster myths of Scylla and Charybdis. Its evil reputation was not confined to legendary times when Ulysses and Aeneas shuddered at its terrors; for its tidal eddies embarrassed the Roman and Carthaginian fleets during the second Punic War.

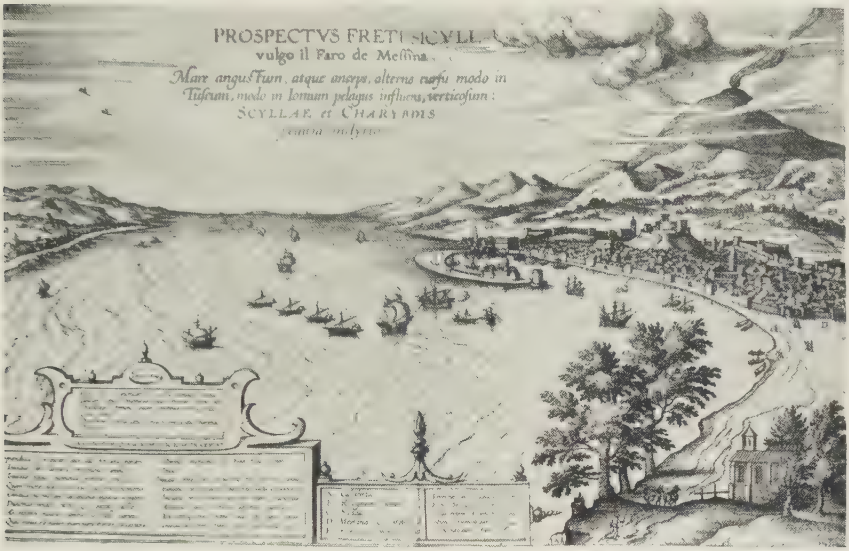
PROSPECTVS FRETI SICVLI
vulgo il Faro de Meſſina.
Mare anguſtum, atque anceps, alterno curſu modo in
Tuſcum, modo in Ionium pelagus influens, verticoſum:
SCYLLAE et CHARYBDIS
fama inclytum

FIG. 8—A seventeenth-century conception of the Strait of Messina. The strait is pictured from the northern entrance: on the left the Calabrian coast with Reggio; on the right Etna with the town of Messina at its foot. (From "Theatrum celebriorum urbium Italiae, aliarumque in insulis Maris Mediterranei," Joannes Jansonnius, Amsterdam, 1652?).

These promontories often caused vexatious delays. Ancient sailing vessels, like modern steamers, had to wait for days till the contrary winds subsided enough for the vessels to round the headlands. The Lectum promontory, forming the southwest end of the Troad peninsula, was a critical point on the sailing route along the eastern shore of the Aegean; for the etesian winds of midsummer swept down from the Black Sea and swirled around this headland with a force which daunted the bravest seaman. Here in the summer of 479 B. C. the Hellenic fleet, bound for the Hellespont from the victory over the Persians at Mycale on the Asia Minor coast, had to moor their ships on the leeward side of Lectum for several days, "being stopped from their voyage by the winds," Herodotus tells us.[19] This was a common experience, evidenced by an altar to the Twelve Great Gods which crowned the summit of Lectum and was said to have been dedicated by Agamemnon himself.[20] The fleet of Corcyra, summoned

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[19] *Ibid.*, IX, 114.

[20] Strabo, *op. cit.*, XIII, 1 : 48.

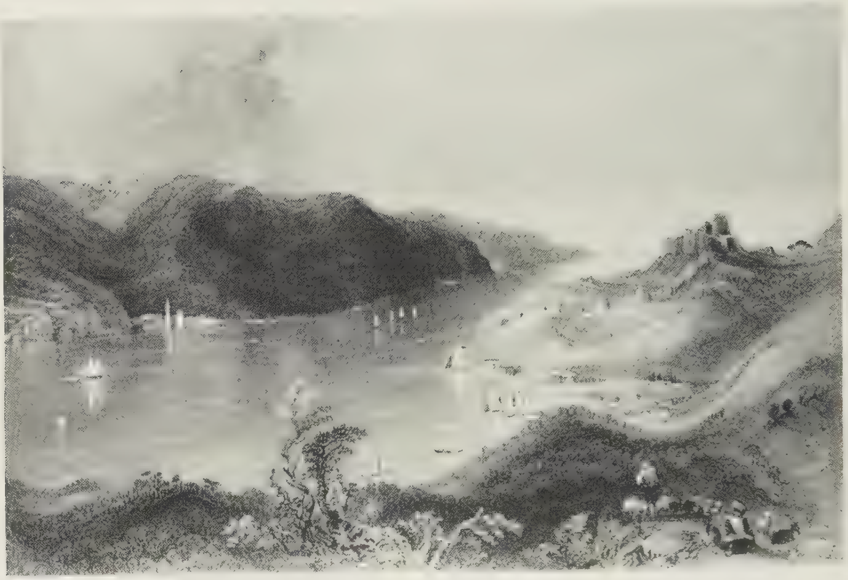

FIG. 9—The entrance to the Black Sea from the Bosporus. (From Julia Pardoe: The Beauties of the Bosphorus, London, 1839. Original drawing by William H. Bartlett.)

to aid the Greek forces at the battle of Salamis, arrived after the fighting was over, claiming that they had been unable to round Cape Malea against the etesian winds, a plausible excuse.[21]

FAMILIAR LANDMARKS

But these promontories were also the first points of the homeland to greet the returning seaman after his eventful voyage, or they marked his arrival in familiar waters. Hence at one of the harbors which usually flanked the ends of the headlands, he beached his ship if the sea was calm and climbed to the summit sanctuary to offer his thanks for a safe journey. Classical literature gives us many instances of this. Jason and the Argonauts, returning from the shadowy land of Colchis and the rocky coast of the Caucasus, rejoiced on reaching the headland that marked the northern entrance of the familiar Bosporus and there built an altar to the Twelve Great Gods.[22] Ever afterwards this spot was sacred and became the site of a temple to Zeus. The Greeks returning from the siege of Troy under Nestor landed at the promontory of Geraestus, which formed the lofty southern tip of Euboea, and there at the temple of Poseidon they sacrificed cattle as a thank offering for their safe return.[23] Another group of these victorious warriors had been shipwrecked on the notorious Cape Caphereus

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[21] Herodotus, *op. cit.*, VII, 168.

[22] Pomponius Mela, *De situ orbis*, I, 19 : 37; Polybius, *op. cit.*, IV, 39.

[23] Homer, *op. cit.*, III, 176.

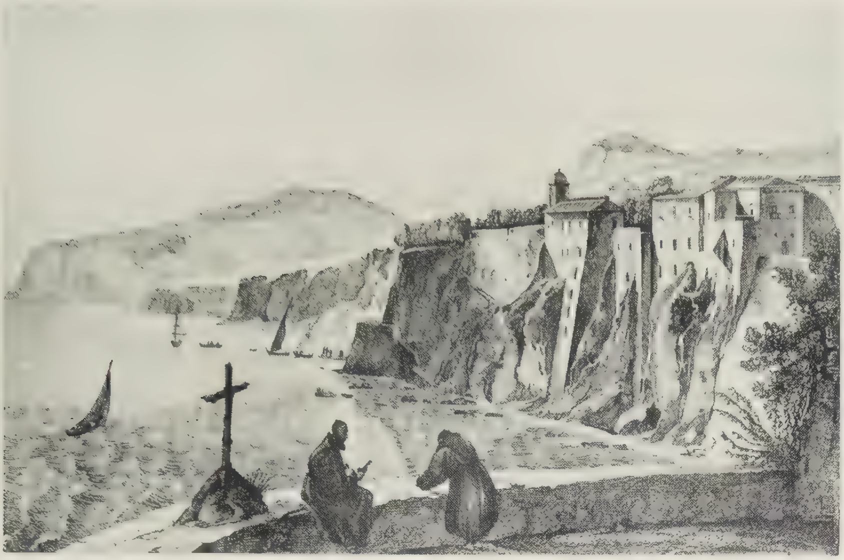

FIG. 10—The bold headlands of the Sorrento Peninsula. (From "Atlante geografico e illustrativo della corografia dell' Italia," [Florence, 1845?], Vol. 4.)

twenty miles to the north, and their fate served to emphasize the good fortune of Nestor and his companions.[24]

Hence these rock-bound capes became the sites of temples, mute prayers in stone for divine protection from the perils of the deep, till the Greek mind came to regard the wooded *temenos*, or sacred precinct, as the normal appurtenance of a promontory. Ajax, dying in the distant Troad, thus describes his native island of Aegina:

> Paths of the dashing surge,
> Caves by the ocean's edge,
> Grove on the promontory brow.[25]

MEMORIALS AND TOMBS ON PROMONTORIES

The tendency to regard promontories as rocky thrones, whence the gods watched over the maritime ventures of men, probably explains the ancient custom of commemorating naval victories by erecting trophies on neighboring headlands, usually in a temple precinct. The Greeks set up a circle of white stone pillars around the temple on the Artemisium promontory of northeast Euboea as a thank offering for the destruction of the Persian fleet in the strait below (480 B. C.). The Athenians, after their victory over the Spartans at the battle of Naupactus (429 B. C.), erected a tropy and dedicated a captured ship in the temple of Poseidon on the Rhium promontory, whence the friendly god had looked down on the engagement in the Corinthian Strait. Augustus Caesar registered his gratitude for the naval victory of Actium by enlarging and beautifying the very ancient temple of Apollo which crowned this headland. Occasionally a promontory received its first dedication by such trophies; as when Corcyra won its great victory over the Corinthian fleet in 435 B. C. and, to commemorate the event, raised a monument on Cape Leucimne, a southern headland of the island hitherto unmarked by any sanctuary, though one is prone to surmise there some native Corcyrean shrine whose god protected his own.

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[24] Ovid, *Metamorphoses*, IV, 472; XIV, 481.

[25] Sophocles, *Ajax*, 412.

FIG. 11—The harbor of St. Nicholas, Cythera. The temple of Aphrodite lay a few miles inland. (From Stackelberg, La Grèce, Vol. 1.)

The sanctity attached to headlands probably explains the ancient custom of placing on them the tombs of heroes, consecrated with altars and monuments. In time the tombs developed into temples and the heroes into gods. The rocky capes that flanked the southern portal of the Hellespont were crowned with sepulchers, raised to the heroic dead of the Trojan War. The high tip of the Chersonesus held the Protesilaeum, tomb and temple of Protesilaus, the first Greek chief killed in the Trojan campaign.[26] The fane grew in sanctity and wealth for centuries; in 480 B. C. it was pillaged and defiled by the Persian viceroy, who, according to Herodotus,[27] paid dearly for the desecration. On a minor headland near by was the sepulcher of Hecuba, queenly victim of the war;[28] and four miles across the swift-flowing Hellespont was the Sigeum promontory, the Westminster Abbey of the early Hellenic race. There under blue Aegean skies rose the temple and tomb of Achilles, which held also the ashes of Patroclus[29] and on which the great Alexander placed a wreath of tribute; there also was the tomb of Antilochus. Three miles beyond, overlooking the mouth of the Scamander, was the Rhoeteum promontory with its sepulchral temple of Ajax.

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[26] Thucydides, *History of the Peloponnesian War*, VIII, 102; Strabo, *op. cit.*, XIII, 1 : 31.

[27] Herodotus, *op. cit.*, IX, 116–120.

[28] Strabo, *op. cit.*, XIII, 1 : 28.

[29] Homer, *op. cit.*, XXIV, 75.

This method of consecrating promontories was not confined to the heroic age. The tomb of Themistocles has recently been identified on the blunt headland overlooking the outer harbor of the Piraeus from the north; and, with rare appropriateness, straight across the harbor channel on the Acte promontory rises the sepulchral monument of the Greek Miaulis, naval hero of the War of Liberation (died 1855). On the west coast of Italy, Cape Palinuri, Cape Miseno, and the promontory of Gaeta all owe their names to the tombs of heroic seamen who explored this coast with Aeneas.

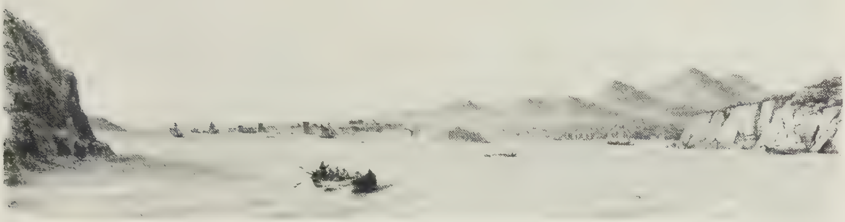

FIG. 12—Modon, the ancient Mothone, a sheltered harbor west of Cape Acritas. (From Stackelberg, La Grèce, Vol. 1.)

Achilles, the son of Thetis, developed into a genuine promontory god. The Euxine and the Propontis became his special domain, and there he was worshipped as the "lord of the Pontus."[30] His altars tipped many a sand and boulder spit along those coasts, and he had a famous sanctuary on Leuce, "the shining island" near the mouth of the Danube whose warders were sea birds;[31] but he also received divine honors on the Aegean island of Astypalea.[32]

THE PROMONTORY GODS

There was a large variety of these promontory gods. Some were primarily marine deities, like Poseidon, Castor and Pollux, the deified Achilles[33] and his goddess mother Thetis who presided over the rocky headland of Sepias. Here the northeast wind from the Black Sea dashed to pieces the Persian fleet of Xerxes as it was preparing to enter the rocky channel of the Euboean sound.[34] The universal maritime activity of the Mediterranean coast peoples, however, diverted other gods from their original tasks to assist the struggling sailor. Zeus became Zeus Soter, savior of seamen, and was assisted in this task by

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[30] J. B. Bury: A History of Greece to the Death of Alexander the Great, 2nd edit., London, 1913, p. 92.

[31] Strabo, *op. cit.*, VII, 3 : 16.

[32] Cicero, *De natura deorum*, III, 45.

[33] Bury, *op. cit.*, p. 92.

[34] Herodotus, *op. cit.*, VII, 191.

Hera, or Juno. Apollo, Athene, and Hermes, god of travelers, were also enlisted in a like service.

Yet remoter deities from inland countries were set to work at the alien duty of helping the ancient navigators. Interesting in this connection is the evolution of Astarte, crescent-crowned moon goddess of Assyria, giver of fertility. She became known to the Phoenicians, who traded along the piedmont route of northern Mesopotamia, as a deity of great power; so they adopted her and took her to their crowded ports on the coast of the Lebanon Mountains. Having little use for her fertilizing powers, they made her patron goddess of their busy merchantmen. The Tyrians placed her figure at the prow of their boats, where she breasted the Mediterranean waves; and they took her on all their wide voyages, to set her up on capes and headlands beside their distant factories and colonies. Tyrian traders introduced her among the Hellenic colonies of Asia Minor, where Astarte became identified with Artemis and achieved fame as the Diana of Ephesus. This hybrid goddess of the crescent was adopted by many Aegean Greek cities as the patron of seamen. She became identified with sea-born Aphrodite, goddess of love and fertility, and as such her worship spread from the Tyrian colony on the little island of Cythera among the peninsular Greeks; but she still retained her Phoenician rôle of patron goddess of seaman.[35] Among the Romans she merged into Venus. Under these various names, but maintaining an identical character, she can be traced all the way from Sidon and Ascalon[36] to Massilia and the Spanish coast, along the sea tracks of Phoenician and Greek settlers.

The Tyrians gave a like distribution to the sanctuaries of their local sea Baal Melkart, who became identified with the Greek Heracles and in this character had his temples and altars on widely scattered headlands from Tyre to the sacred promontory of Iberia. Under his Roman name he presided over the Pillars of Hercules, where he looked down upon the full current and strong winds of the famous strait. Malign deities represented the terrors of dangerous headlands and were embodied in the Scylla monster who destroyed ships in the whirlpool of the Strait of Messina:[37] she also occupied the Scyllaeum promontory of southeastern Argolis,[38] where the etesian winds at midsummer swept around the end of this peninsula. Similar was the Italian Circe who lured seamen to their destruction on the surf-beaten rocks of the Circaeum promontory.[39] Similar too were the Sirens, localized by legend on the rocky islets off the Sorrento peninsula.

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[35] Pauly-Wissowa, article "Astarte."

[36] Herodotus, *op. cit.*, I, 105.

[37] H. F. Tozer: Lectures on the Geography of Greece, London, 1873, p. 77.

[38] Pausanias, *op. cit.*, II, 34 : 7-8.

[39] Cicero, *op. cit.*, III, 48: Vergil, *Aeneid*, VII, 10-24; Apollonius of Rhodes, *op. cit.*, III, 312; Strabo, *op. cit.*, V, 3 : 6.

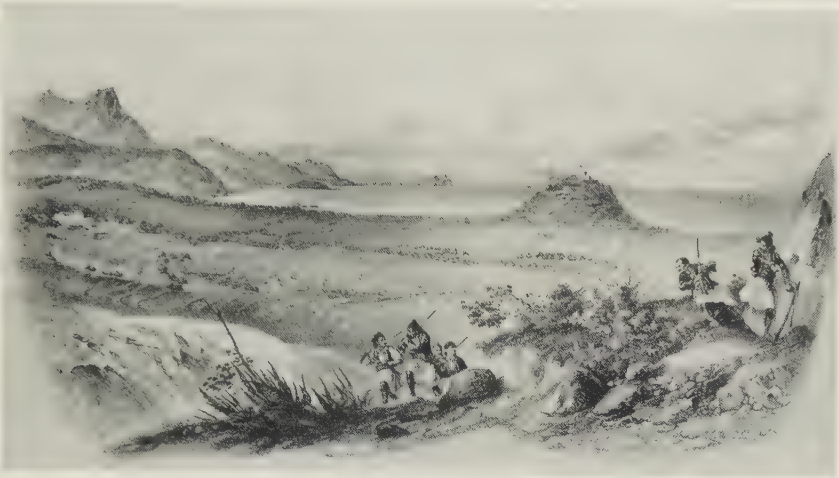

FIG. 13—The central peninsula of the Peloponnesus with its termination in Cape Taenarum (C. Matapan). (This view and Figure 2 from Stackelberg, La Grèce, Vol. 1.)

All of these deities, both beneficent and malignant, had their seats upon the headlands of the Mediterranean shores. A fragment of Sophocles thus apostrophizes the god of the sea:

> Thou Poseidon, who art lord over the cliffs and glassy
> waves of the wind-swept Aegean, behold thy dwelling place
> on the lofty crags of all the harbors.

Poseidon was "enthroned on Geraestus and Sunium bold," according to Aristophanes.[40] He had his famous sanctuary on the long promontory of Cape Matapan, the ancient Taenarum (Fig. 13), where a grove and cave sheltered the image of the god.[41] The little harbor to the northeast of the sacred precinct was a refuge for storm-driven seamen; it was also the starting point for the voyage south to Crete and Africa and thence to Egypt.[42] The Venetians later called it the Bay of the Quails, because these birds of passage assembled there for their flight to the winter grainfields of Egypt.

In like manner Apollo was ensconced upon the windy promontories. "Many are thy fanes and groves, and dear to thee are all the headlands," sings the Homeric hymn to Apollo.[43] He frequently shared these sites with Artemis, who "was goddess of the stormy headlands." Aphrodite was called "the giver of fair voyages," "she who keeps a lookout from the headlands," "Aphrodite of the Heights." On a little promontory which sheltered the port of the city of Aegina from the north winds was a temple dedicated to "Aphrodite of the Harbor" (Figs. 15 and 16), now marked by a single surviving column.[44] Her

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[40] Aristophanes, *The Knights*, 559–560.

[41] Strabo, *op. cit.*, VIII, 5 : 1; X, 1 : 7; Pausanius, *op. cit.*, III, 25 : 4.

[42] Conrad Bursian: Geographie von Griechenland (2 vols., Leipzig, 1862, 1872), Vol. 2, p. 150.

[43] Homeric Hymn to Apollo, 143–144.

[44] Pausanias, *op. cit.*, II, 29 : 6.

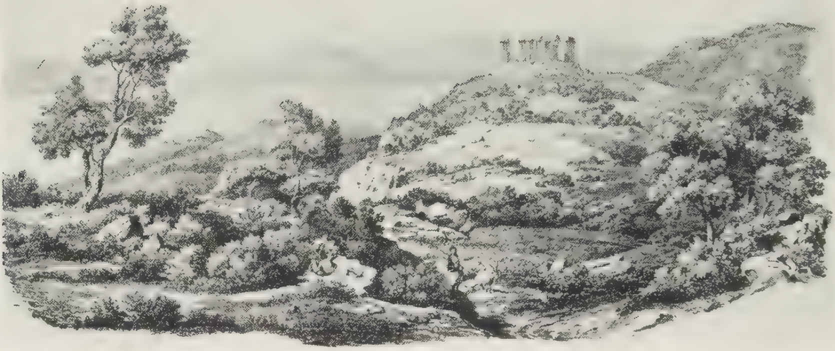

FIG. 14—The temple of Athene in Aegina. In the background the coast of Attica. (From Stackelberg, La Grèce, Vol. 1.)

character is described by Anyte of Arcadia, who wrote in 700 B. C. a poem to Aphrodite of the Sea:

> Cythera from the craggy steep
> Looks downward on the glassy deep,
> And hither calls the breathing gale
> Propitious to the venturous sail,
> While Ocean flows beneath serene,
> Awed by the smile of Beauty's Queen.

The ancient Greek city of Cnidus, which occupied the rocky tip of the Triopium promontory on the southwest coast of Asia Minor, dedicated its oldest sanctuary to the Bountiful Aphrodite, a later one to Aphrodite of the Height, and a third to the Aphrodite of the Fair Voyage.[45] This Cnidian Aphrodite was clearly a Greek form of the Phoenician Astarte, who appears on the island of Samos as Hera,[46] and as Artemis in Hellenic Euboea and on the native shores of the ancient Argonauts. Orpheus, bard of these daring explorers, according to Apollonius Rhodius "sang of the Savior of Ships, Artemis, her that holds the headlands of these seas in her keeping."[47]

Athene also was drawn into the service of the Mediterranean seamen. She had her temple on "sacred Sunium,"[48] near the famous shrine of Poseidon, and shared with him the task of assisting seamen to round this windy promontory. As "Guardian of the Anchorage" she had her sacred seat on a rocky cape sheltering the port of Hermione on the southern coast of Argolis, while a temple of Poseidon kept its

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[45] *Ibid.*, I, 1 : 3.

[46] *Ibid.*, VII, 4 : 4–5; Encyclopaedia Britannica, article "Hera."

[47] Apollonius of Rhodes, *op. cit.*, I, 568.

[48] Homer, *op. cit.*, III, 278.

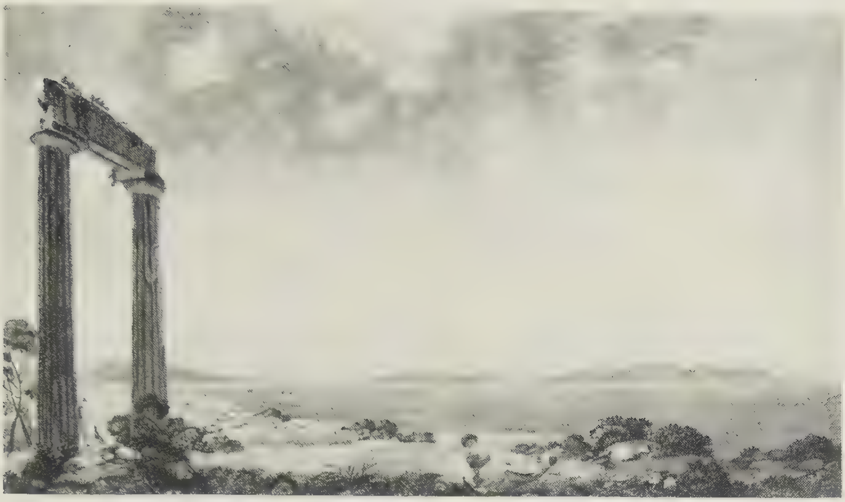

FIG. 15—Ruins of the Temple of Aphrodite at Aegina as seen in the late eighteenth century. Compare Figure 16. (From "The Antiquities of Ionia," Part II, Society of Dilettanti, London, 1797.)

lookout on a neighboring headland.[49] Athene was "mistress of the winds" in her sanctuary on the southwest promontory of Messenia, where she protected the sailors seeking their home port of Mothone (Fig. 12);[50] for this point was exposed to the storms that swoop down from the Adriatic and to the violent south winds of spring that bring rain from the coast of Africa.

Christian Saints Replace the Promontory Gods

These gods have passed, but their function still remains; their headlands are not deserted. In the Aegean Sea nearly all these high temple sites are occupied today by little chapels of St. Nicholas, the patron saint of sailors brought up in the Greek Catholic Church. St. Nicholas is dear to the heart of the modern Aegean seamen. His icon is fastened to the mast of every fishing boat, and below it hangs an ever-burning lamp. Prayers ascend to him in every storm, and sacrifices of salt and bread are cast into the sea by the pious sailors when they round his promontories.[51] Many of these little churches are located on the very site of the ancient pagan sanctuaries, and one may see sculptured stones from an Aphrodite or Poseidon temple built into the chapel walls. In the western Mediterranean, in the realm of the Roman Catholic Church, the Virgin Mary is the Stella Maris, Star of the Sea, to the modern sailor; humble successor of Artemis and Venus, she has her chapel or church on the site of ancient temples and is besought in prayer by the modern Sicilian or Italian sailor for a safe voyage.

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[49] Pausanias, *op. cit.*, II, 34 : 8–10.

[50] *Ibid.*, IV, 35 : 1, 5, 6.

[51] Mary Hamilton: Greek Saints and Their Festivals, Edinburgh and London, 1910, pp. 28 31.

HARBOR PROMONTORIES AND THEIR SANCTUARIES

These promontory sanctuaries reveal two geographic principles in their distribution. They appear singly or in groups about the harbor entrances of active seaboard towns, where headlands run out like piers and protect the port from prevailing winds. The ancient sailing vessels evidently experienced difficulty in getting into harbor, though they used the diurnal winds for this purpose, as the Mediterranean sailor does today. But these sea breezes were comparatively weak and often were overpowered by the stronger currents of air. Moreover, along the steep coasts of the Mediterranean falling winds or squalls from the highland interiors added to the complexity of the wind systems and increased the difficulty of reaching port, especially on southward-facing slopes.[52] They explain the successive headland temples along the whole south coast of Asia Minor and of the Troad along the base of Trojan Ida, of mountainous Crete and Rhodes, southern Italy, and the seaboard of the Alps and northern Apennines. Along the Italian Riviera, the Portus Herculis of ancient Monaco,[53] Portus Delphini[54] near modern Rapallo (Fig. 20), and Portus Veneris near Spezia had their names from promontory shrines.

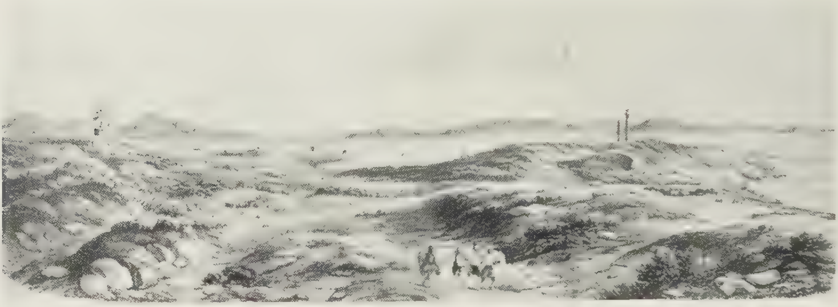

FIG. 16—The port of Aegina and the ruins of the temple of Aphrodite. In the middle distance is a chapel of St. Nicholas. (From Stackelberg, La Grèce, Vol. 1.) Stackelberg (1834) says: "It is reported that the better preserved of the two columns has fallen down and the débris used in the building of new houses."

These port sanctuaries were numerous. The ancient Hellenic colony of Massilia (Marseilles), by reason of its location near the mouth of the Rhone, lay in the path of the mistral, the desolating wind that pours down the Rhone valley from northern France and the Cévennes. The ancients knew it in winter to overturn loaded wagons crossing the Rhone delta and in the summer sailing season to buffet vessels entering or leaving the port of Massilia. The harbor was a natural basin between two limestone ridges of the Provence hills, which afforded protection against the mistral and determined the selection of the site by the ancient Phocaean colonists. These Asia Minor Greeks, coming from a region long impressed with Phoenician cults, brought with them the worship of Artemis of Ephesus and erected a temple to her on the northern headland protecting the port, where today rises the old cathedral of Marseilles. On other bold points abutting on their harbor they built sanctuaries to Apollo and Poseidon and thus fortified themselves against the stormy mistral. Nor was this all. They planted their colonies and temples along the whole Mediterranean shore of Gaul and of the neighboring Iberia.[55] The remoter Massiliot colonies on the Spanish coast often found it impossible for weeks at a time to send their ships northward to the mother city against the mistral. They found it especially perilous to round the bold Pyrenean promontory, which was therefore crowned with a temple to Aphrodite.[56]

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[52] C. Naumann and J. Partsch: Physikalische Geographie von Griechenland, Breslau, 1885, pp. 104–107; Alfred Philippson: Das Mittelmeergebiet, Leipzig, 4th edit., 1922, pp. 96–97.

[53] Lucan, *Pharsalia*, I, 405; Strabo, *op. cit.*, IV, 6 : 3.

[54] Pliny, *Hist. nat.*, III, 7.

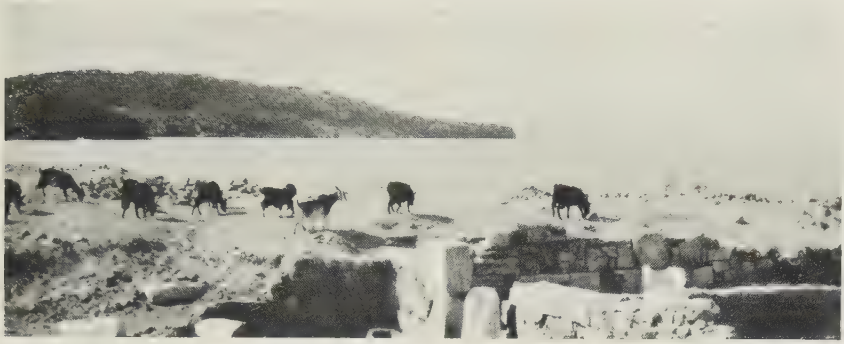
FIG. 17—Ruins of a temple discovered in 1926 at Zoster. The Zoster Promontory on the west coast of Attica, a bold rocky headland, had altars to Apollo Zosterios, Artemis, Leta, and Athene Zosteria.

The southwest coast of Asia Minor suffered from the falling winds from the highlands of Lycia and the plateau interior; so the Greek cities along this coast studded the promontory approaches to their harbors with sanctuaries of the helpful gods. The city of Cnidus was located on the tip of the Triopium peninsula and a near-by islet, which was linked with the mainland by a causeway and thus formed an anvil-shaped headland sheltering two harbors (Figs. 21 and 22). On the lofty island extremity Cnidus placed a famous temple of Apollo, sacred to seamen along all that coast,[57] and one to Poseidon, while in her three sanctuaries in the city Aphrodite was cherished above all its other gods.[58] Cnidus, by reason of its restricted territory, its barren rocky soil, its meager home resources, and its crossroad location on the great north-south and east-west trade routes of the eastern Mediterranean, was early drawn into commercial and fishing ventures on the sea. Therefore its chief need was reflected in its worship of these sea deities. The near-by city of Halicarnassus, with a similar location and a similar career, had a harbor well protected both by nature and the gods (Figs. 23 and 24). A northern headland, in the form of a precipitous rock, contained its citadel and a temple of Aphrodite, while another sanctuary crowned the corresponding promontory on the south.[59] The neighboring city of Miletus, famous in ancient commerce and colonization, was located on a club-shaped peninsula fronting the mouth of the Meander River (Figs. 25 and 26). The southern tip of this peninsula held an altar to Poseidon, said to have been founded in gray antiquity by Neleus, who established the Ionian colony of Miletus; while two miles inland on the promontory summit was the famous temple of Apollo of Didymus.[60] This was a rich sanctuary visible from afar, sought as a place of prophecy by all the dwellers of the Ionian coast. The temple itself was of Ionian origin, but it occupied the site of a far earlier sanctuary, which had probably been established by the early Carians of this coast.[61]

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[55] Strabo, *op. cit.*, IV, 1 : 3–4.

[56] *Ibid.*, IV, 1 : 6.

[57] Thucydides, *op. cit.*, VIII, 35.

[58] Pausanias, *op. cit.*, I, 1 : 3.

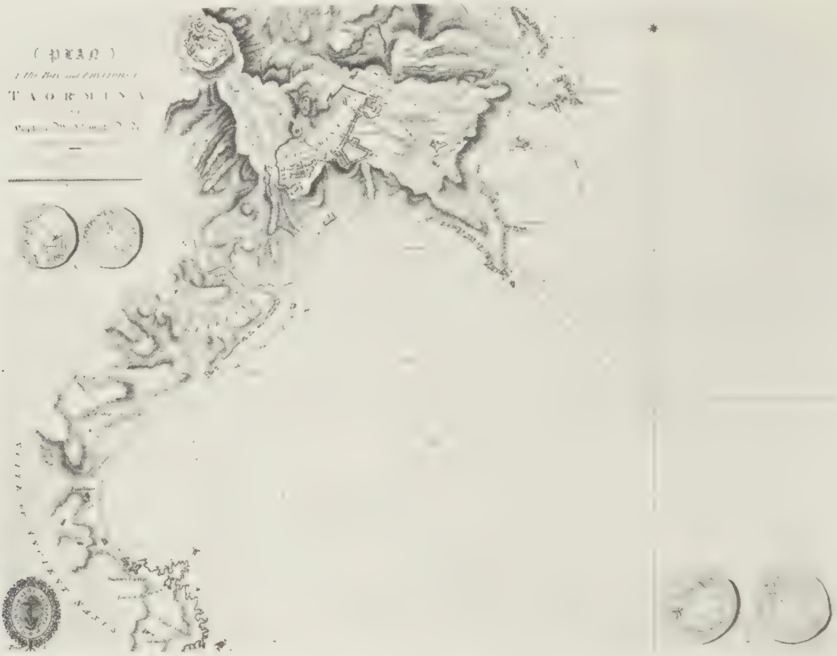

FIG. 18—Plan of the Bay of Taormina. Temples on the flanking promontories. Compare Figure 19. (From "The Hydrography of Sicily, Malta, and the Adjacent Islands; Surveyed in 1814, 1915, and 1816 . . . by Capt. William Henry Smyth," London, 1823.)

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[59] Vitruvius, *De architectura*, II, 8; Diodorus Siculus, *op. cit.*, XVII, 23 : 4.

[60] Strabo, *op. cit.*, XIV, 1 : 5; Herodotus, *op. cit.*, V, 36; VI, 19; Pausanias, *op. cit.*, II, 10 : 5.

[61] Pausanias, *op. cit.*, VII, 2 : 3.

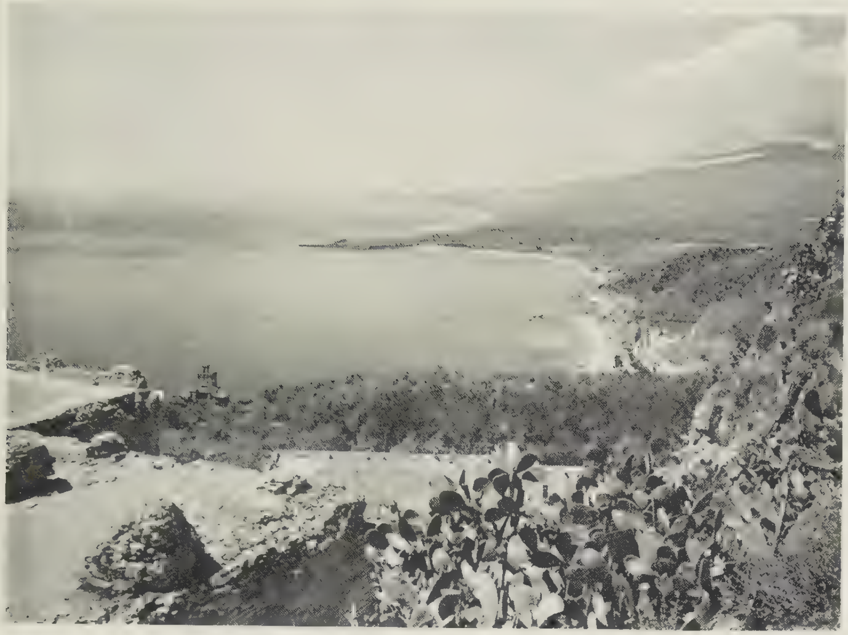

FIG. 19

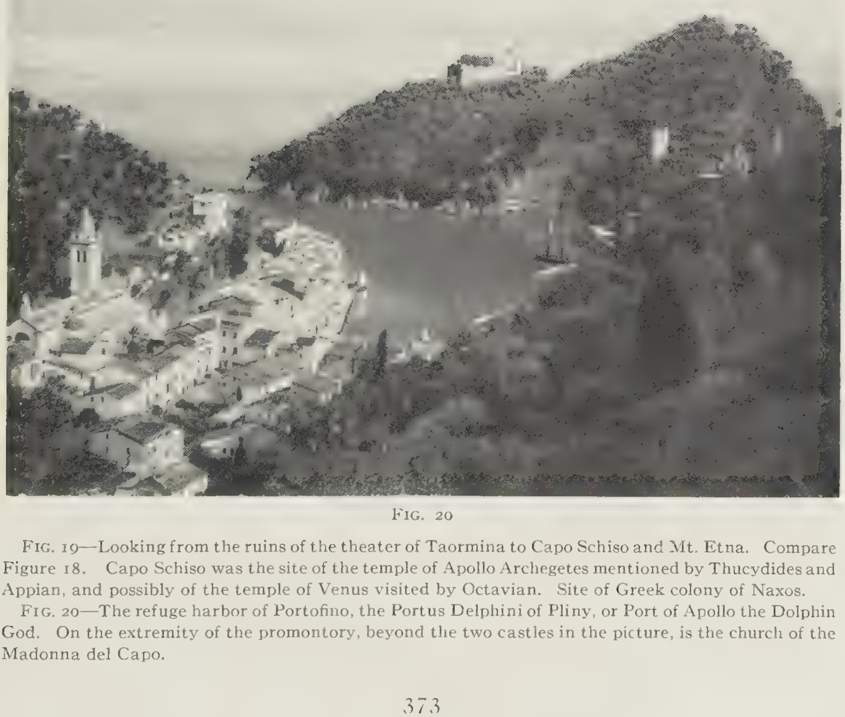

FIG. 20

FIG. 19—Looking from the ruins of the theater of Taormina to Capo Schiso and Mt. Etna. Compare Figure 18. Capo Schiso was the site of the temple of Apollo Archegetes mentioned by Thucydides and Appian, and possibly of the temple of Venus visited by Octavian. Site of Greek colony of Naxos.

FIG. 20—The refuge harbor of Portofino, the Portus Delphini of Pliny, or Port of Apollo the Dolphin God. On the extremity of the promontory, beyond the two castles in the picture, is the church of the Madonna del Capo.

On the peninsula of Greece the same story meets us. On Acte promontory, which sheltered the ports of Athens, a temple of Artemis protected the home-coming sailor.[62] Corinth, located on the Isthmus of Corinth, had no available promontory, but she constructed a long mole to shelter Cenchreae, her Aegean port, and on the tip she placed a bronze statue of Poseidon.[63] The high promontory (3467 feet) on the western side of the Isthmus (Fig. 29), which guarded the approach to her harbor on the Corinthian Gulf, was crowned with a temple of Hera Acraea.[64] The tip of this headland is now called Cape St. Nicholas, and its summit bears a humble chapel to that helpful saint.[65] Even the land-loving Spartans had their two ports of Gythium and Las, on the mountainous coast of the Laconic Gulf, protected by a promontory temple, one to Aphrodite and the other to Artemis Dictynna.[66] In like manner these headland sanctuaries clustered thick about the ancient ports of Alexandria, Byzantium, Syracuse, Naples, Carthage, New Carthage, and Gades.

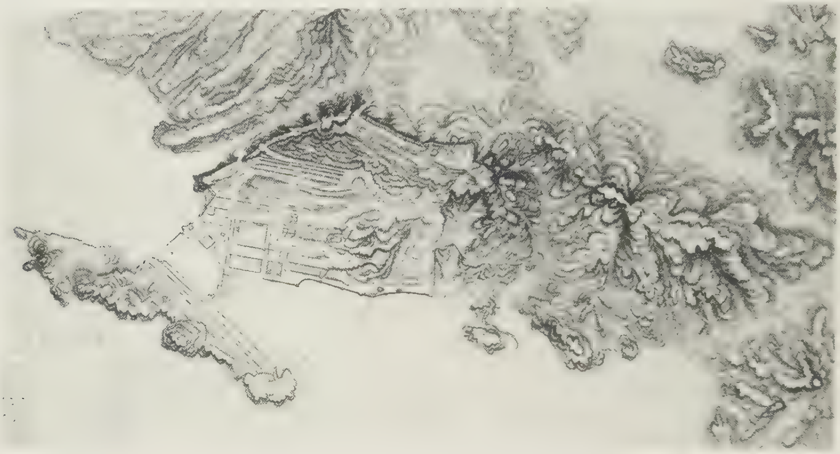

FIG. 21—Plan of Cnidus, built on the Triopium promontory and the adjacent island. Compare Figure 22. (From "Antiquities of Ionia," Part III, Society of Dilettanti, London, 1840.)

ALONG THE TRACK OF THE GRAIN SHIPS

The second principle of distribution is revealed along the main trade routes of the Mediterranean Sea. The temples are found on all these "wet ways" along the coast where conflicting winds and currents meet and where the surf beats high. The long path of the Hellespontine wind, which blew from the Scythian coast of the Black Sea down through the Bosporus and Hellespont and swept southwestward across the Aegean, marked the great northern grain route of the ancient Mediterranean; hence it was punctuated by templed promontories. The high water level in the Black Sea in early summer, due to the great volume of the northern rivers, caused a strong current out through the Crimean Bosporus and again through the Thracian Bosporus and Hellespont into the Aegean. Ships northward bound to the Scythian grainfields had to sail up against the Hellespontine wind and also breast this current, which through the tortuous channels of the Straits rebounded from shore to shore and greatly complicated the problem of navigation. Hence the jutting banks of the Crimean Bosporus had their sanctuaries to Artemis, Heracles, and Achilles.[67] Temples marked both headlands flanking the Euxine mouth of the Thracian Bosporus; and halfway down the strait other sanctuaries capped the promontories of Hermes and Heracles, which received the violent impact of the current rebounding from the Asian side.[68] At the southern end, where northbound vessels met the full force of current and etesian wind, several temples marked the elbow of the Asian coast at Calchedon;[69] and the opposite headland of Byzantium was crowned by sanctuaries to Poseidon, Athene, Artemis, Aphrodite, and Heracles, all within three hundred yards of its hilly extremity, while altars of Achilles and the twin Dioscuri lay near the city of By-

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[62] Xenophon, *Hellenica*, II, 4 : 11.

[63] Pausanias, *op. cit.*, II, 2 : 3.

[64] Livy, *History*, XXXII, 23; Xenophon, *op. cit.*, IV, 5.

[65] Alfred Philippson: Der Peloponnes, Berlin, 1891, pp. 19–28.

[66] Pausanias, *op. cit.*, III, 22 : 1; Bursian, *op. cit.*, Vol. 2, p. 147.

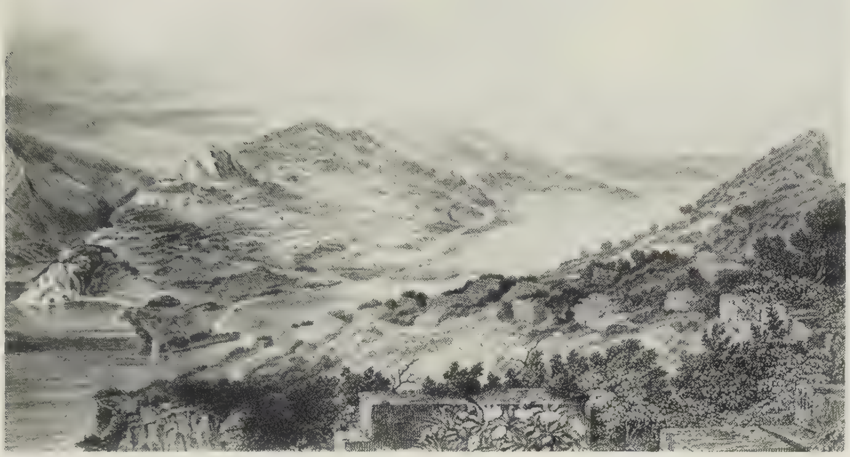

FIG. 22—View of the site of the ancient city of Cnidus taken from a point in the peninsula westward of the entrance into the smaller harbor. Compare Figure 21. (From "Antiquities of Ionia," Part III, Society of Dilettanti, London, 1840.)

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[67] Pliny, *op. cit.*, IV, 26; Strabo, *op. cit.*, XI, 2 : 6–8; E. H. Minns: Scythians and Greeks, Cambridge, 1913, pp. 21–23.

[68] Polybius, *op. cit.*, IV, 39, 43, 44; Strabo, *op. cit.*, VII, 6 : 1.

[69] Xenophon, *op. cit.*, I, 3.

zantium.[70] This diverse group of deities represented the patron gods of the various seamen who frequented the busy port of the Golden Horn.

THE EUBOEAN SOUND ROUTE

The Hellespontine wind made perilous sailing at the entrance to the Malic gulf and the Euboean sound, where the rocky headlands showed their teeth to approaching vessels. All these headlands therefore, were capped with temples or altars to Artemis, Thetis, Athene, and Zeus the Savior.[71] The Euboean sound itself is protected from the Hellespontine blast by the long mountainous island of Euboea, which forms a breakwater and wind shield. But the Euripus or narrows of the sound, which contracts to two hundred feet between Aulis and Chalcis, was dreaded by ancient seamen because of the tidal rips which formed here and shifted four times in the twenty-four hours (Fig. 32); and also because of the squalls dropping from the high massif of Mt. Dirphys (5725 feet)[72]. With adverse winds and tide it was impossible to pass these narrows. Here under the lee of "Aulis rising high above the waves," was a little harbor where vessels were wont to await a change of wind and current.[73] In this port of refuge

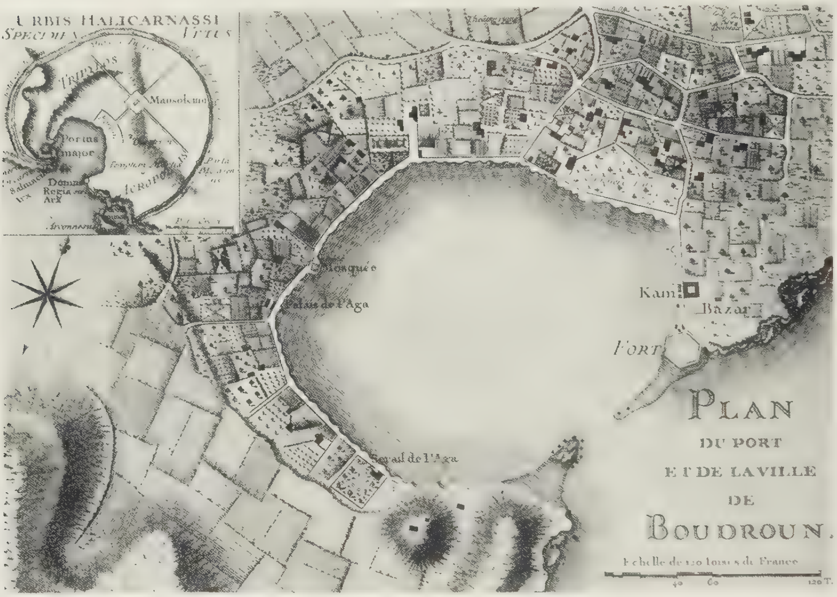

FIG. 23—Plan of the port of Budrum (Halicarnassus); inset, the ancient city. Compare Figure 24. (From Comte de Choiseul-Gouffier: Voyage pittoresque de la Grèce, Paris, 1782, Vol. 1.)

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[70] Pauly-Wissowa, article "Byzantion."

[71] Sophocles, *Trachiniae*, 238, 752–754, 993; Diodorus Siculus, *op. cit.*, XI, 12; Strabo, *op. cit.*, IX, 5 : 22; Apollonius of Rhodes, *op. cit.*, I, 568.

[72] Livy, *op. cit.*, XXVIII, 6.

[73] Euripides, *Iphigenia in Aulis*, 122, 157.

Agamemnon and the Greek fleet, assembled for the campaign against Troy, were detained for weeks by head winds; and here finally, at the sanctuary of Artemis, Agamemnon sacrificed his daughter Iphigenia, that the goddess might facilitate their departure.[74] The altar of Artemis that crowned this little promontory became a place of sacrifice for later military ventures setting forth across the Aegean from the shores of Greece.[75] The pagan sanctuary has disappeared; the perils to navigators have persisted; a little chapel to St. Nicholas watches here today over the fate of the seamen.

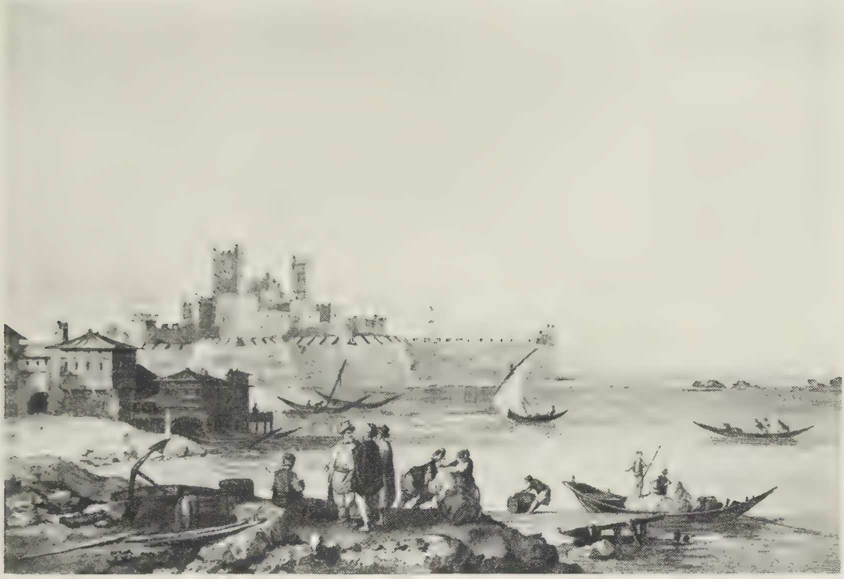

FIG. 24—View of the port and citadel of Budrum (Halicarnassus). Compare Figure 23. (From Choiseul-Gouffier, Voyage, Vol I.)

ROUNDING THE SOUTHERN PELOPONNESUS

The Hellespontine wind carried the current from the Hellespont southwestward across the Aegean. Side by side they swept around the southern end of Euboea and of Attica, where Poseidon from both rocky heights overlooked the stormy passage, and with undiminished force maintained their way southwestward to merciless Malea. This headland forms the eastern prong of the mountain trident of southern Peloponnesus, the other two being Taenarum and Acritas. All three flanked the course of vessels seeking Italy and the western Mediterranean, and all were buffeted by conflicting winds. Acritas on the west was swept by gales moving southward out of the Adriatic. All three at times were exposed to the southwest wind from Africa, and all knew the squalls sweeping down from the highland of Arcadia. They felt "the south wind warring with the north" described by Horace, the surf breaking on their hidden reefs, and the spume of the sea on their rocky fronts. Hence, besides the promontory sanctuaries, there were altars to Apollo Acritas, to the Malean Apollo, and to Taenarian Poseidon in the city of Sparta, where prayers preceded every Laconian venture on the deep.[76]

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[74] *Ibid.*, 90, 178, 350, 1450, 1540–1580.

[75] Xenophon, *op. cit.*, III, 4 : 3–4.

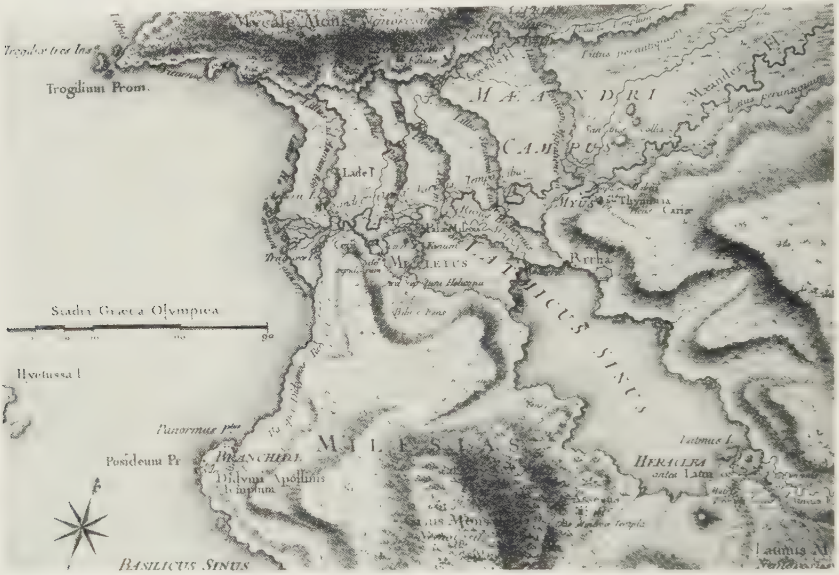

FIG. 25—Map of the vicinity of Miletus showing various stages in the silting up of the gulf between Miletus and Priene by the Maeander. Compare Figure 26. (From Choiseul-Gouffier, Voyage, Vol. 1.)

But Malea was worst of all. "The blasts of whistling winds and swollen waves as huge as mountains," which drove the returning Menelaus south to Crete,[77] have continued to give the cape a bad name for storms and heavy seas through all time. The Spartan fleet that set out for Syracuse in the Peloponnesian War was caught by the Hellespontine wind off the cape and swept south to Africa. The fleet of Belisarius in 533 A.D., bound from Constantinople to Carthage, rejoiced to round Malea in calm weather.[78] Therefore the ancient seamen safeguarded themselves by establishing here four sanctuaries. A temple to Apollo Epidelius flanked the promontory on the east;[79] sanctuaries to Apollo,[80] Zeus, and Athene[81] capped the bold spurs of the cape itself, while from the summit of Cythera a temple to Aphrodite, or Astarte of Phoenician origin, looked down on the boisterous channel between island and headland (Fig. 11).[82] The Parnon range, which tapers off southward to form Malea, is a ridge of bare, black limestone, 2600 feet high, dropping steeply to the surf at its base. A sheer cliff, 200 feet high, supports the last narrow ledge, on which are now two chapels and a hermit's cave.[83] Malea still retains its terrors. It overlooks a busy sea lane, dotted by the sails of sponge fishermen in quiet weather, as by the boats of the Phoenician purple gatherers in ancient times. Ocean liners plow past, oil tankers and grain ships from the Black Sea hold their course westward; but in stormy weather steamers and fishing smacks alike are held up for days.

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[76] Pausanias, *op. cit.*, III, 12 : 5, 8.

[77] Homer, *op. cit.*, III, 287–290.

[78] Procopius, *De bello vandalico*, III, 13 : 5–7.

[79] Strabo, *op. cit.*, VIII, 6 : 1.

[80] Thucydides, *op. cit.*, VII, 26.

[81] Pausanias, *op. cit.*, III, 22 : 10; 23 : 1.

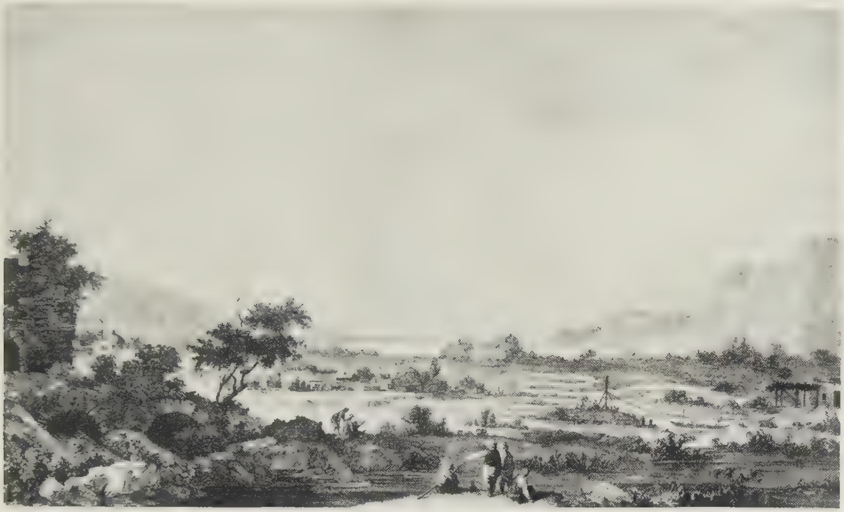

FIG. 26—The ruins of Miletus and the course of the Maeander. Compare Figure 25. (From Choiseul-Gouffier, Voyage, Vol. 1.)

The ancient east-west sailing route may be traced by these promontory temples, set up like milestones at every port of call, all the way from Cyprus past Crete and Malta to the Pillars of Hercules. When vessels left the shelter of the Asia Minor coast on their sunset voyage, they sailed along the leeward side of Rhodes past Lindus to escape the north wind; but they encountered it again till they succeeded in passing the templed promontory of Salmonium at the eastern extremity of Crete, a perennial point of danger.[84] Here the Apostle Paul met rough sailing on his voyage to Rome in the autumn of 40 A.D. His vessel found easy going along the sheltered southern coast of Crete and was lucky in having a gentle south breeze for rounding the templed promontory of Lissus,[85] because it was mid-October and far too late even for a grain ship from Egypt to be abroad in the Mediterranean. So the inevitable happened: the wind circled around to the northeast and the tempestuous Euroclydon, counterpart of the Italian bora, swept over the Mt. Ida range (8200 feet) of Crete into the Bay of Phaestus (modern Bay of Messara). It pounded Paul's vessel and drove him with the Greek crew for nine days westward to Malta.[86] It was generally an involuntary voyage, captained by the arbitrary god of the winds, that carried an ancient vessel across the open sea from Crete to Malta. These were dangerous waters. The promontory protecting the bay of Malta was crowned in Cicero's time by a temple of Juno, very ancient, very rich, and held in peculiar veneration;[87] and another headland was dedicated to Melkart from the early Phoenician appropriation of the island.[88]

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[82] Herodotus, *op. cit.*, I, 105.

[83] Philippson, Der Peloponnes, pp. 175–176.

[84] Apollonius of Rhodes, *op. cit.*, IV, 1693.

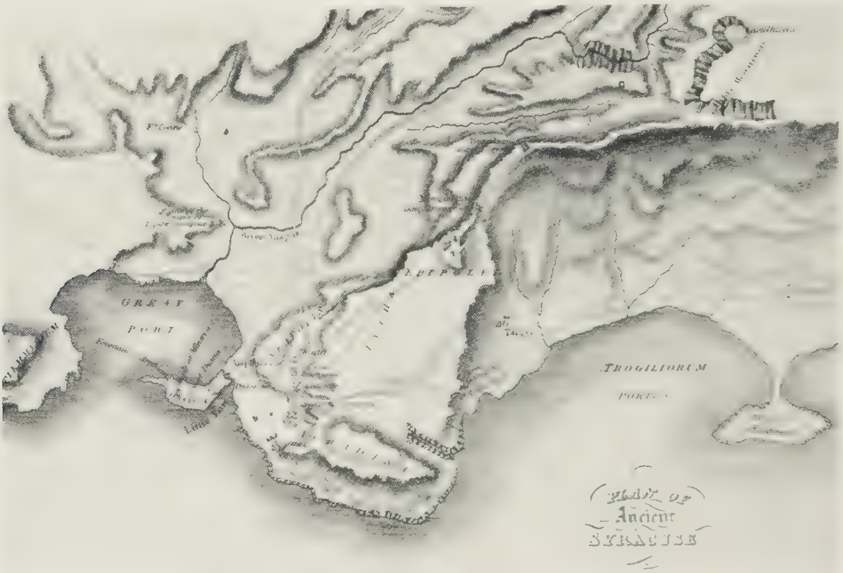

FIG. 27—Plan of ancient Syracuse. The city was situated on the island of Ortygia, which, connected with the mainland by mole and bridges, formed a promontory protecting the Great Harbor. Note the temples to Minerva and Diana. Compare Figure 28. (From T. S. Hughes: Travels in Sicily, Greece, and Albania, London, 1820, Vol. 2.)

THE ISTHMIAN ROUTE TO ITALY AND SICILY

To avoid Malea and shorten the voyage between the Saronic and Corinthian gulfs, ancient passenger vessels and small freighters with valuable cargoes took the isthmian route across Greece, making the four-mile transit of the Isthmus by the diolcus, or roller tramway, maintained by Corinth. The importance of this passage, despite the isthmian tolls, is attested by the promontory temples flanking the route. Westbound vessels issued from the narrow Corinthian Strait between two temples of Poseidon, crowning the Rhium and Antirrhium promontories (Fig. 30),[89] and turned thence northward along the coast past the dreaded Leucadian headland to Corcyra, whence they crossed the Strait of Otranto to Italy.[90] They struck land near Hydruntum (Otranto) where a temple of Mercury welcomed them from afar; or. sailing twenty miles farther south, they reached the promontory tip of Italy. Its summit was crowned by the temple of Athene Leucadia, which Aeneas saw on approaching the Italian shore.[91] This spot is now occupied by the church of Santa Maria di Leuca, or the Madonna in Finibus Terrae. Only the platform of the old temple remains, but in the limestone cliff is a grotto containing ancient petitions of passing sailors to Jupiter Optimus.[92]

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[85] Philostratus, *Life of Apollonius of Tyana*, IV, 34.

[86] Acts of the Apostles, 27 : 7-14.

[87] Cicero, *In Verrem*, V, 46.

[88] Ptolemy, *Geography*, IV, 3, 37.

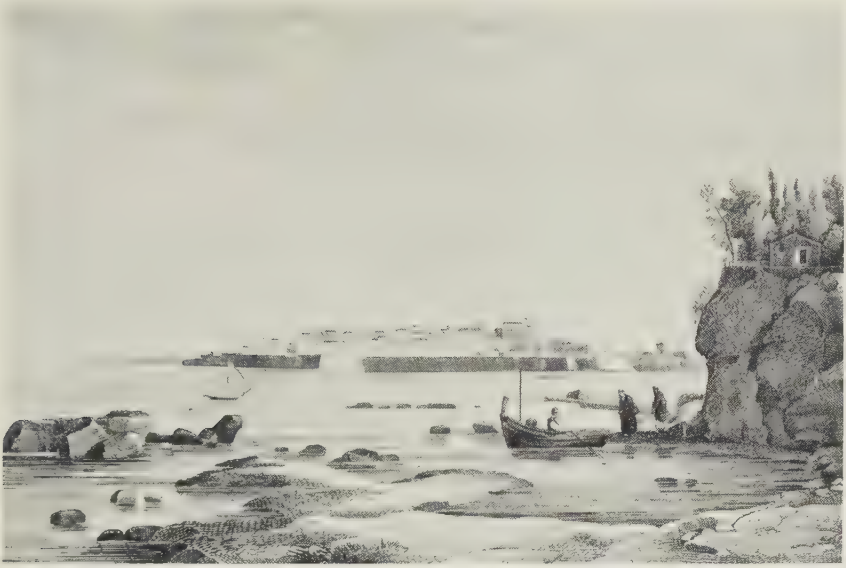

FIG. 28—View of Syracuse. Compare Figure 27. (From "Atlante geografico e illustrativo della corografia dell' Italia," [Florence, 1845 ?], Vol. 4.)

From this point the vessels steered across the broad opening of the Gulf of Tarentum to the Lacinian promontory, site of a temple to Hera, who was apparently successor to an earlier goddess, native to the place. This was once the most hallowed temple of Magna Graecia and held annually a great panegyric.[93] Today a solitary column, twenty-six feet high, rises from the massive substructure and gives the headland the name of Capo delle Colonne,[94] while near by is the church of the Madonna del Capo, to which young girls go barefoot in procession every Saturday. Fifteen miles to the south is a second promontory, once sacred to Castor and Pollux.[95] The destination of most Greek ships coming from the Gulf of Corinth was Sicily, whose rich grainfields and pastures helped to supplement the meager food supplies of the old Greek cities. The eastern coast of Sicily was studded with templed promontories marking the entrances to the colonial ports,[96] while sanctuaries of Poseidon and Artemis on the Pelorus headland safeguarded the perilous Strait of Messina.[97]

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[89] Thucydides, *op. cit.*, II, 86; Pliny, *op. cit.*, IV, 3.

[90] Vergil, *op. cit.*, III, 275, 506-508; Thucydides, *op. cit.*, VI, 42–44.

[91] Vergil, *op. cit.*, III, 530–532.

[92] A. J. C. Hare: Cities of Southern Italy and Sicily, London, 1883, p. 326.

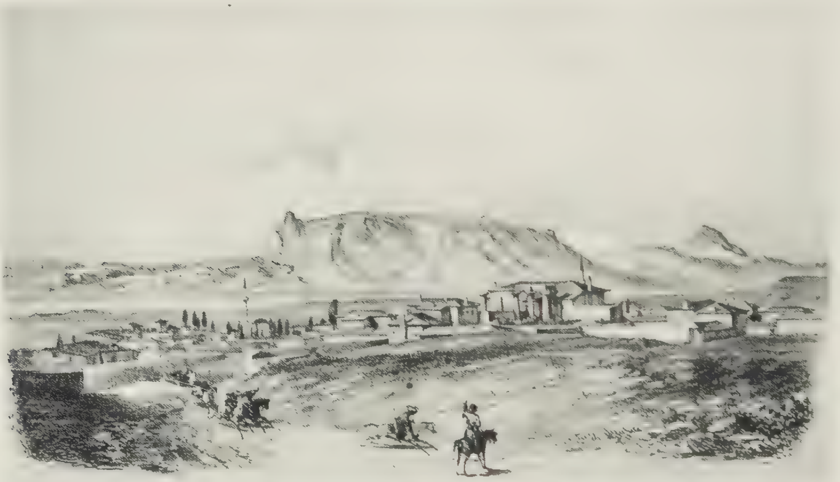

FIG. 29—View of Corinth from the citadel, looking towards the Gulf. The rocky promontory in the background runs from Mt. Gerania (on the right) westward to terminate in the headland now called Cape St. Nicholas. (From Stackelberg, La Grèce, Vol. 1.)

All three corners of triangular Sicily endangered navigation, and all were sites of famous temples. The Pachynum promontory at the south, *imbriferos Pachynos*, with its Apollo sanctuary was swept by north winds streaming down the Strait of Messina and also by southwest gales from the Atlas Mountains.[98] It was therefore the scene of frequent shipwrecks. The most famous promontory shrine of perhaps the whole Mediterranean capped the northwestern angle of Sicily, where the massive headland of Eryx rose to the height of

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[93] Livy, *op. cit.*, XXIV, 3; Diodorus Siculus, *op. cit.*, IV, 24 : 7; Aristotle, *De mirabilibus auscultationibus*, 96.

[94] Hare, *op. cit.*, pp. 340–350.

[95] Pliny, *op. cit.*, III, 15.

[96] Thucydides, *op. cit.*, VI, 3; Cicero, *In Verrem*, IV, 53; Appian, *Bello civili*, V, 12 : 100.

[97] Diodorus Siculus, *op. cit.*, IV, 5, citing Hesiod; Strabo, *op. cit.*, VI, 1 : 5.

[98] Ovid, *op. cit.*, XIII, 725; Macrobius, *Saturnalia*, I, 17 : 24; Polybius, *op. cit.*, I, 37, 54.

2463 feet and made a second Malea.[99] On its level summit the early Phoenician colonists established their goddess Astarte and filled the grove about her temple with doves that figured in her worship. To the Greek colonists of Sicily she was Aphrodite of Eryx; she became Venus of Eryx when the Romans conquered the island and embellished her shrine.[100] At present her sanctuary site is occupied by the cathedral of Our Lady of Eryx, patron saint of the Sicilian sailors, Stella Maris of the Sicilian sea (Fig. 31). Hither pilgrims come from all parts of Sicily to make their offering for safe voyages, and they admire the doves which still wing their way from tree to tree in the surrounding grove. The sacred site has never changed, nor the human need; only the divine encumbent has assumed a different name and different guise.

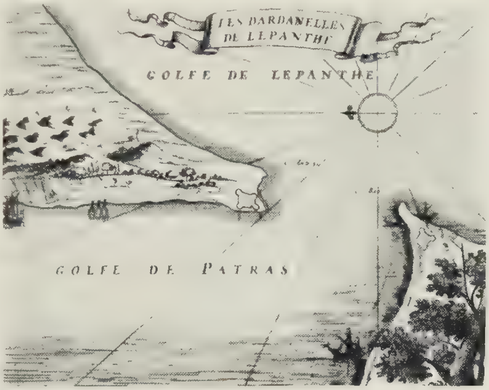

FIG. 30—Map of the Strait of Lepanto. The Venetian forts crowning the narrows, in antiquity the points known as Rhium (south) and Antirrhium (north), are on the site of temples to Poseidon. (From O. Dapper: Naukewrige Beschryving van Morea, Amsterdam, 1688.)

SACRIFICES TO PROMONTORY GODS

The promontory gods who were expected to rescue men from dire peril were appeased by offerings of cattle and even of human lives. Artemis in her more primitive forms was propitiated by human sacrifices, like that of Iphigenia at the temple of Aulis. This barbarous phase of her cult tended to appear as a heritage from Astarte, wherever the Tyrians established their factories or fishing stations. It characterized the sanctuary of Artemis on the Parthenium promontory of southwestern Crimea among the Taurii, who cast shipwrecked seamen from the cliff of the headland as offerings to Artemis of the deep;[101] for the Taurii were fishermen and pirates, preying upon Greek vessels trading with the Crimean coast. The cult was either indigenous, belonging to a native Parthenia, or virgin goddess, on whom the Artemis worship was grafted; or it was borrowed from the Tyrians who maintained their purple-fishers' camp on the coast.[102] Certainly it was not borrowed from the Greeks. In the drama of Euripides the translated Iphigenia, who officiated as priestess in the gloomy Parthenian temple, voiced all the repugnance of the Hellenic mind to the barbarous features of the cult.[103]

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[99] Polybius, *op. cit.*, I, 55; Vergil, *op. cit.*, V, 759–773.

[100] Freeman, *op. cit.*, Vol. 1, pp. 277–280, 548–551.

[101] Pomponius Mela, *op. cit.*, II, 3; Herodotus, *op. cit.*, IV, 103; Strabo, *op. cit.*, VII, 4 : 2; Pliny, *op. cit.*, IV, 26.

[102] Euripides, *Iphigenia in Tauris*, 262–264.

Yet similar features characterized the cult of Apollo on the Curias promontory in southwestern Cyprus, long under Phoenician influence. There anyone who touched the altar of the god was cast into the sea to propitiate the deity.[104] But the most dramatic scene was yearly enacted at the temple to Apollo on the Leucadian promontory of southwestern Leucas (Fig. 6). The forces of air and sea multiplied the dangers of rounding this headland, which thrust out a rocky spur six miles in length and 2000 feet in height, rising in sheer cliffs of white limestone right across the path of the Adriatic winds. This was "the

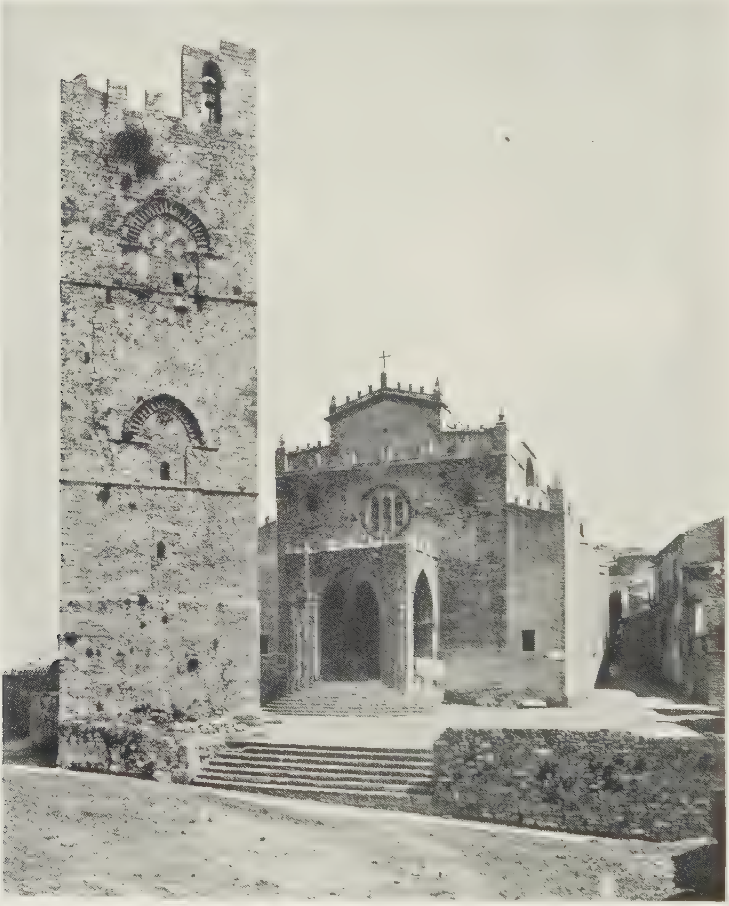

FIG. 31—Cathedral of Our Lady of Eryx on the Promontory of Eryx, successor of a temple of Astarte and of Venus of Eryx.

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[103] *Ibid.*, 34-41, 380-405.

[104] Strabo, *op. cit.*, XIV, 6 : 3; Thucydides, *op. cit.*, III, 94.

far projecting rock of woe," known and dreaded by ancient Greek and Roman sailors.[105] In order to avoid it the sand and boulder reef that connected Leucas with the mainland was pierced as early as 500 B. C. by an artificial canal. But waves and currents repeatedly barricaded the opening and forced vessels to round the Leucadian promontory. Here again the exigencies of the case demanded human sacrifices, which evidently figured in the cult of the Leucadian Apollo from the gray dawn of history. Strabo gives us the story. Once a year on the feast day of the god a criminal who had forfeited his life was cast from the top of the cliff into the sea. But the moral refinement of a more cultured age raised a protest against the barbarity. Hence, before the victim was thrown over the cliff, he was provided with crude Daedalian wings and numerous doves were attached by strings to his person, in order that the fluttering of their pinions might break the force of his fall. Below on the water a group of expectant fishermen waited in their boats, ready to pick up the victim, if he should survive the fall, and carry him as an exile out of the country. One can imagine the scene—the bold, gleaming cliffs, the temple of Apollo on the summit, down below the white-winged fishing boats, with their sturdy sailors looking upward for the appearance of the victim, awe and fear and hope depicted on their countenances. But the Leucadian promontory was merciless in a storm; the god up there held no sinecure.

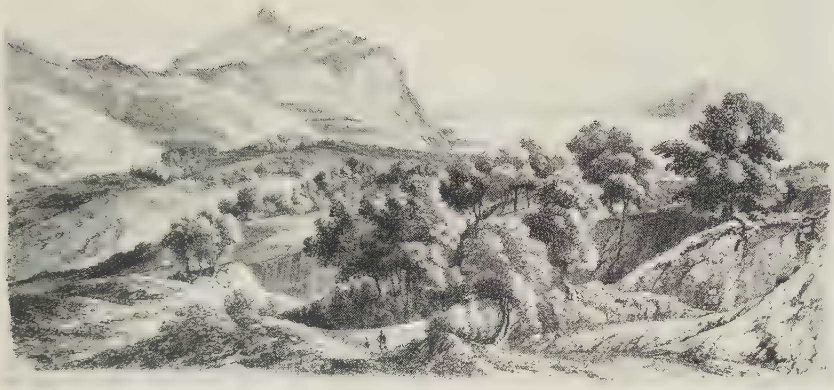

FIG. 32—The narrow and dangerous channel between Aulis and Chalcis. (From Stackelberg, La Grèce, Vol. 2.)

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[105] Strabo, *op. cit.*, X, 2 : 8–9.

Though one hundred and seventy-five of these templed promontories have been identified, a few stormy headlands which by every law of geographical probability should have been sanctuary sites have not proved true to type. The Mt. Garganus promontory (3460 feet), the spur of Italy, though exposed to the dread bora sweeping down the Adriatic, held minor local shrines but none to a sea god. Notorious as Malea was Cape Caphereus "the Devourer," a rocky prong jutting out from the southeast coast of Euboea into the teeth of the Hellespontine winds. It was the graveyard of the ancient Aegean; its funeral chants sound through all classical literature.[106] But it had no saving shrine. Its evil genius was represented by Nauplius, whose misleading fires lured to destruction the Greek heroes returning from the siege of Troy.[107] The few who were washed ashore on Caphereus found only a cave, containing an altar and image of Dionysus, but they welcomed the warming gift of the god of wine.[108]

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[106] Euripides, *The Troades*, 90–91.

[107] Propertius, *Poems*, III, 7 : 39; Euripides, *Helena*, 1129; Ovid, *Tristia*, I, 1, 83; V, 7, 36.

[108] Pausanias, *op. cit.*, II, 23 : 1; IV, 36 : 6.

INISHMORE: AN OUTPOST ISLAND*

Lester E. Klimm

University of Pennsylvania

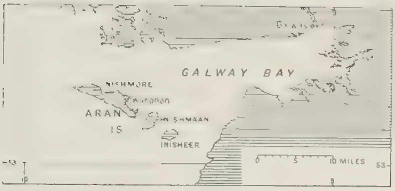

FIG. 1—The Aran Islands, "mere bare ribs of rock," lying off the west coast of Ireland.

IN our world of today highly developed systems of transportation and communication, added to differences of resource, topography, and climate, have given rise to an industrial civilization based on exchange. Our production is largely production for sale. This all seems so much a part of our surroundings that we seldom stop to consider that such has not always been the case and that it is by no means universally true now.

Many regions enter little into trade because they have little or nothing to offer to the outside world: they make up a surprisingly large percentage of the earth's surface. The dry deserts, the cold deserts, the rocky wastes, and areas shut off by mountains or other barriers from communication with the outside, support small, self-sufficient populations in which the rest of the world is not economically interested. An example of such an area on a small scale is Inishmore, or Aranmore, the largest of the Arans, a small group of islands lying off the mouth of Galway Bay on the west coast of Ireland. Before entering into a description of the island and its people, it would be well to note that the Aran islands are not in an out-of-the-way corner of the earth but within a day's journey of modern Dublin and but eleven hours farther from London. Lack of resources alone keeps Inishmore from progress.

The photograph, Figure 2, shows an islander, a little less than the average in height but otherwise typical. He is clothed from the neck down entirely in products of island manufacture. The nautical cap on his head is a relic of a trip in a Norwegian herring schooner, but every other article of clothing is native. His woolen sweater, trousers, and socks are made from the fleece of island sheep. The moccasins, or "pampooties," are made from the hide of a cow raised on the island and bound together with strips cut from the same hide. He paused in his fishing to pose rather self-consciously for this picture.

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* Read before the twenty-third annual meeting of the Association of American Geographers at Philadelphia, December 28–30, 1926. The writer spent two weeks on Aranmore in the summer of 1926.

THE ISLAND ITSELF

What is the environment that produced this man? The island is about nine miles long and two broad in its widest place. It runs roughly northwest to southeast. Its surface is of an almost bare limestone rising from the level of the sea to an elevation of three or four hundred feet in the interior (Fig. 3). The lines running hither and yon without any apparent reason are fences of the loose limestone rocks of the surface piled in an attempt to clear the little fields to some small extent of the stones which litter them. The first impression is of barrenness, and it is not belied by a closer inspection. There is not a tree on the island, and only a feeble growth of brush in some of the sheltered and better-watered spots.

The east coast (Fig. 4) is low and approachable if your boat is not too large. For this reason all but about 100 of the 1800 people of the island live in this section. Sand has drifted in here and helps to give the island what little naturally cultivable land it has. The land rises rather rapidly to the central backbone of the island in a broken series of terraces (Fig. 5) almost entirely bare of soil and of vegetation. The limestone is cracked and seamed to relatively great depths, and there are no surface streams: it is a typical karst. Westward the surface falls rather sharply in a long line of steep cliffs standing from 100 to 300 feet high facing the Atlantic (Fig. 6).

At the census of 1911, the last for which details are available, there were 1779 people on this island in an area of 12 square miles. This is a density of 148 to the square mile which is greater than that for any of the states of the United States except the five manufacturing states of Rhode Island, Massachusetts, Connecticut, New Jersey, and Pennsylvania. It exceeds by a good deal that for rich agricultural states like Illinois, Indiana, or Iowa. With its scarcity of agricultural land, such a population density means a low standard of living. The area has lost population slightly in every census period.

FISHING

This is the land in which our islander is trying to make a living. The first consideration is, of course, food. The sea lies all about him and is teeming with fish—sometimes. He catches herring, mackerel, bream, and rockfish during the summer. If the run is small, they are eaten sparingly fresh, the largest part dried, and some salted for use in the winter.

Fishing is not a business involving schooners, large crews, and expensive tackle. It is a dangerous, laborious expedition in the light canoes or curraghs (Fig. 9) almost identical with those in use when the Romans first came to Britain. The only change is the substitution of canvas for cowhide as covering. In these frail craft four men will brave high waves when the fish are running well. Their oars are mere slats with no breadth to the blade. The islanders say that with these there is less danger of "catching a crab" while rowing in a choppy sea, and their boats are so light as not to need heavy oars.

Fishing by hand lines or small nets from the boats or from the rocks on the shore is the only method open to these people, for there is not enough capital available in the islands to purchase larger boats. It can be easily imagined that these primitive methods do not produce much of a surplus above the food needs of the people except when the fish are running exceptionally well and command a high price on the mainland.

Even if the fish are running well, however, starvation may face the fishermen because of weather too rough for them to venture out in their little boats or too wet to allow for drying of the fish before they spoil. The islanders are now complaining that British and Belgian steam trawlers are spoiling their fishing grounds.

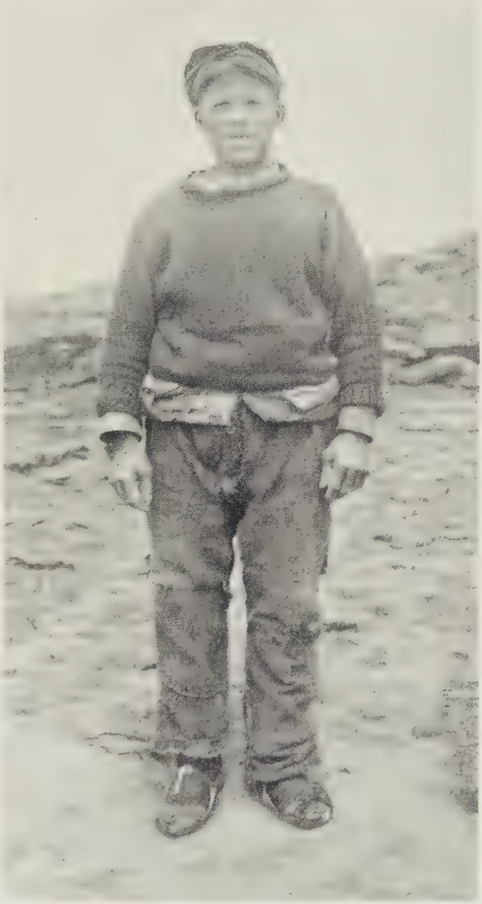


FIG. 2—An inhabitant of Inishmore clothed, with the exception of the cap, entirely in products made on the island. Note the primitive moccasins.

AGRICULTURE AND STOCK RAISING

Life on Aran is not all fishing, however: the islander contributes to his food supply by agriculture and stock raising. His agriculture is of the intensive, small-field variety, for the areas where any soil is present are scarce and small, and the omnipresent limestone rocks make difficult the work of clearing a field (Fig. 7). In fact, land is so scarce that some has actually been made. Sand is carried in baskets from the beaches of the eastern coast and spread on the bare rock: this

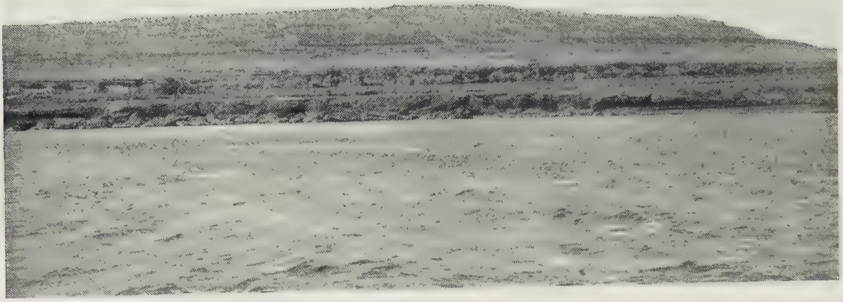
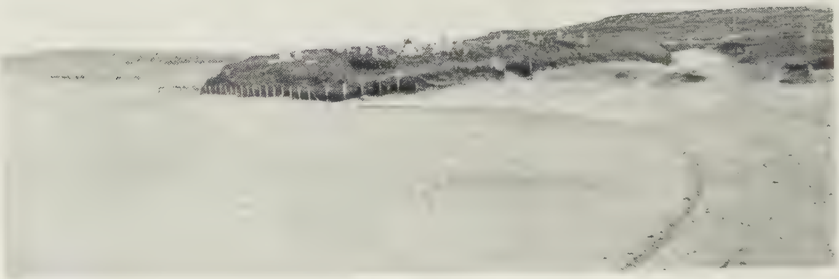


FIG. 3



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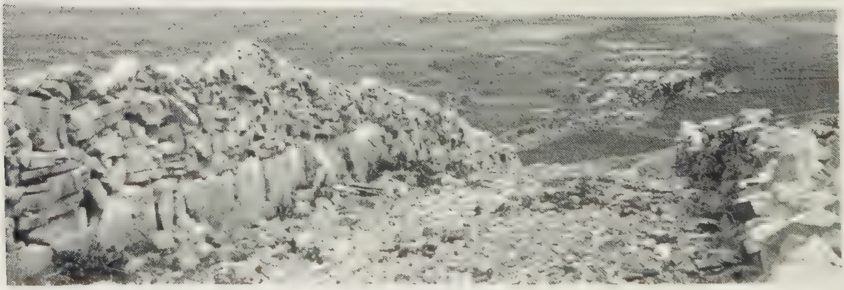


FIG. 5

FIG. 3—A section of Inishmore from the sea. Note the limestone fences dividing the fields.

FIG. 4—The low, sandy leeward coast. The cemetery is in a dune, crop land being too valuable.

FIG. 5—Looking across the island toward the north. The maze of fences and the large areas of rock outcrop are much in evidence.

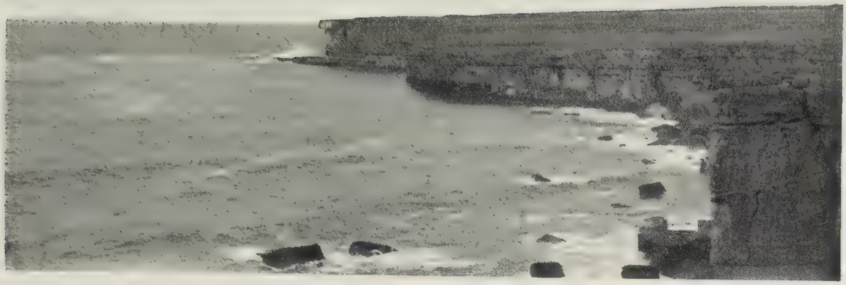
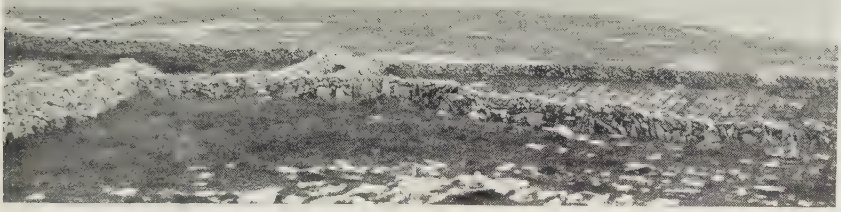


FIG. 6



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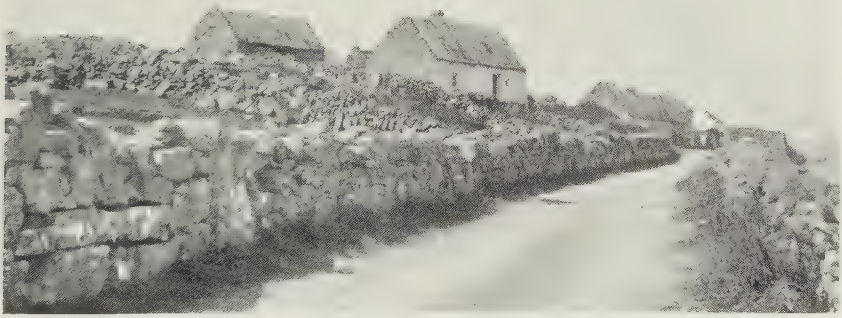

FIG. 8

FIG. 6—Looking up the west coast. The cliffs range from 100 feet to 300 feet in height.
FIG. 7—Agricultural land: the white patch in the distance is bare limestone.
FIG. 8—Typical island dwellings built of limestone thatched with rye straw.

is covered with a layer of seaweed and then another layer of sand and another of seaweed. After a few years this compost has become amalgamated enough to raise a scant crop of potatoes.

Potatoes are the principal crop. They have the advantage of growing well in the limey soil and giving a relatively large yield from a small acreage. The thin soil, however, becomes parched if it does not receive rainfall on the average every three days. There is hardly ever a surplus of potatoes, and if there is it is usually fed to the pigs. Rye is the only other considerable crop. The yield is only sufficient to furnish seed for the next year. The straw is used for thatching, and its cultivation gives the potato land a rest. Small fields of beets and turnips are planted occasionally, largely to supplement the winter pasture of the stock.

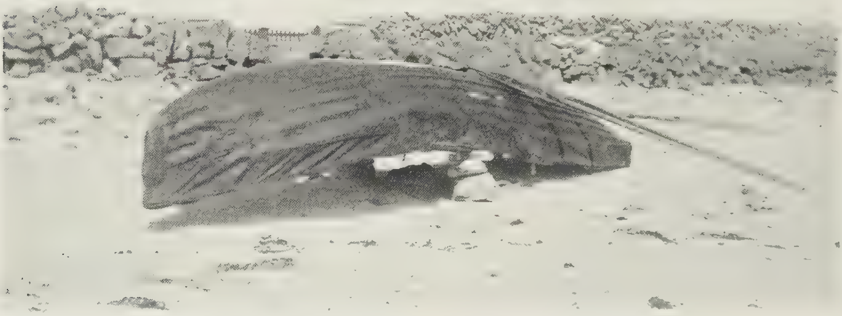

FIG. 9—The curragh, or seagoing canoe, of the Arans. It is common to the west coast of Ireland and is a descendant of the cowhide-covered boat of the ancient Britons.

Such is the simple and rather difficult system of agriculture. Land is too scarce to permit of much crop rotation: fish and seaweed are the only fertilizers.

It is only in stock raising that there is any surplus from the land. Pasture is found in scattered areas on the thin soil of the central ridge. There are seldom more than three or four cattle to a family. Each maintains two milch cows and raises what calves its pasturage will allow. Even in the most prosperous homes beef is too valuable to appear often on the table. The beeves are sold on the mainland and frequently form the only cash income of the family. The climate is mild enough so that cattle are left outdoors the year round, the more sheltered pastures being kept for the winter. The only barns are for horses and the storage of tools and fishing equipment.

Pigs are kept by nearly every family, as they are cheap feeders. Potatoes, turnip tops, and the scant table scraps are the principal feeds. Pork is the meat oftenest seen on the island tables though seldom enough at that. There are almost no sows. The young pigs are bought on the mainland in the spring and raised on the island. When grown they are either eaten or shipped back to Galway for sale. Sheep are raised on the pasture that is too poor for the cattle. Most families own a few, and they provide wool for the almost universal manufacture of homespun. Their carcasses give an occasional feast of mutton.

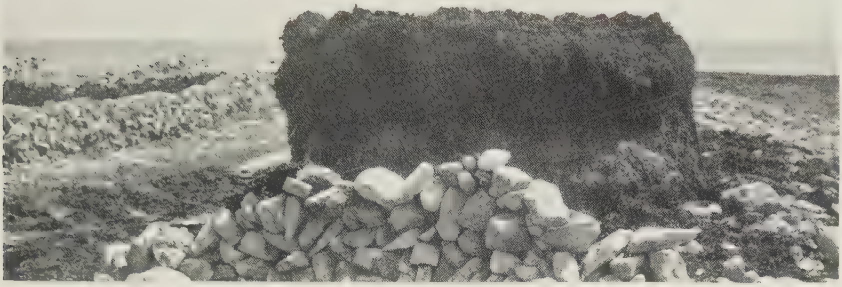

FIG. 10—A pile of dried seaweed ready to be burned to produce the "ore" from which iodine is extracted.

SHELTER AND FUEL

The source of the clothing of the island has already been described. Only the most difficult of articles to manufacture, or those for which no materials are at hand, are bought from the outside.

The demand for shelter is rather easily met (Fig. 8). The climate, though wet, is never severe. The surface is littered with limestone suited to building purposes, and the local lime makes fine mortar and whitewash. The small rye fields supply thatch for the roofs, which are renewed yearly. Rafters, doorsills, and furniture have to be made of expensive imported lumber. Often the furniture in the poorer cottages is made of driftwood from some wreck on the rugged western coast.

Fuel is one of the few vital elements not in large measure supplied by local materials. As has already been indicated, there is not a tree on the island, and the brush is scarce and small. The barren limestone has no turf covering to yield the principal fuel of the mainland.

It is here that the need of a cash crop is most keenly felt. Before the small surpluses of fish, cattle, hogs, or kelp can be applied to the purchase of even condiments or tools, the year's supply of peat must be obtained from the mainland. This hard-earned fuel supply is eked out with cow dung, very carefully saved and plastered on the stone walls to dry. Indeed, many families burn nothing but cow dung for cooking all summer, saving the precious turf for the heating needs of the winter, when a fire must be kept burning continually.

The tools needed in such an existence are few. The boats are made on one of the islands, but the wood and canvas have to be imported. They are patched until they look like Lazarus' coat, and when the canvas wears thin the natives slap on an extra coat of tar and, without the least hesitation, set out on a night's journey to sea, following the fish. Fishing tackle, hardware, and the simple agricultural tools are imported and are, therefore, very carefully preserved.

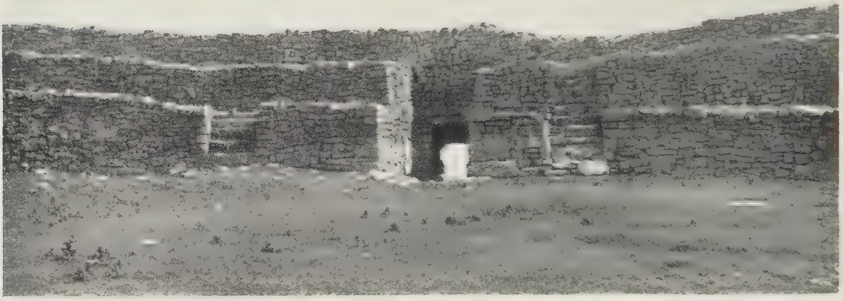

FIG. 11—The gate to the inner fort at Dun Aengus from the inside. This dry stone has been standing for about 20 centuries. The wall is about 25 feet thick at the base.

INDUSTRIES

The only industry in the island which is carried on solely with a view to a production for sale is the drying and burning of kelp, a source of iodine (Fig. 10). The seaweed is laboriously gathered from the rocks and spread out to dry, not always a successful process because of lack of sunshine. Once dried it is burned in pits to the clinker-like mass in which it is marketed. Four tons of seaweed must be gathered to make one ton of the material of commerce. The continuous labor of three or four men for over twelve hours is needed to stir the burning kelp of each pit filling—a half ton. The price in 1926 was between six and seven pounds sterling, or $25.00 to $30.00 a ton. The return is so small that the amount of kelp produced varies inversely with the ease of catching fish, as the latter yields larger return per unit of labor.

Another industry which has recently grown to be of some importance to the islands is the entertainment of the few visitors who come there during the summer. Most of these are school teachers from the mainland who come here and spend a month brushing up their Gaelic, as this is the almost universal language of the islands.[1] Some are wandering archeologists or students of literature who wish to visit the antiquities in which the islands abound.

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[1] See note "Irish and Welsh Speech in the British Isles," elsewhere in this *Review*.

ANTIQUITIES

Perhaps the most interesting of these relics is Dun Aengus (Fig. 11) an old fort standing on the northwestern cliffs and suggesting the last outpost of an outpost kingdom. It has often been described by archeologists.

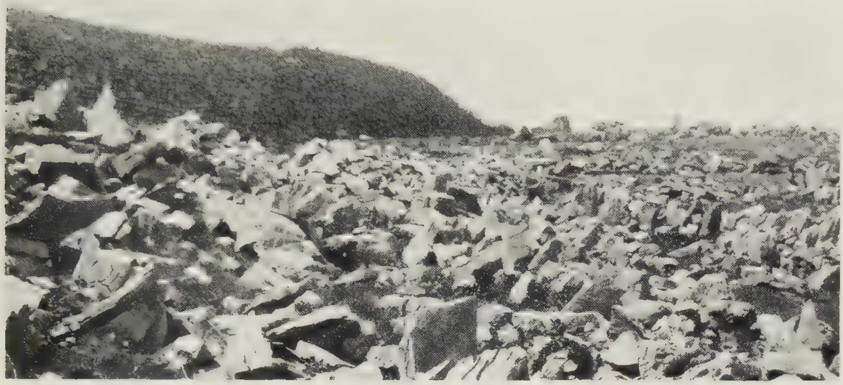

FIG. 12—The *chevaux-de-frise* of jagged limestone on the approach to the fort of Dun Aengus.

> Many of us still remember the sense of almost inaccessible remoteness that attached to "the Aras of the Sea." All who have visited the spot feel the "repellent attraction" of the gigantic precipice and the swirling abyss over which the fort is so airily poised. Then there is the pathos—no less of the legend that made it the refuge of a doomed and hunted race than of its own inevitable destruction—that invested the broken grey walls on the farthest edge of the old world.[2]

The fort consists of a series of three walls forming three roughly concentric semicircles with the arcs extending toward the east and the back to a cliff that drops 350 feet to the Atlantic. The diameter of the outer circle is about 900 feet and that of the inner one about 150 feet. As one progresses from the outer to the inner walls, these works grow higher and thicker until the wall of the inner circle is 25 feet in thickness, made up of the limestone which lies loose all over the surface of the island. The stones are laid together without any mortar, but the work is in a fine state of preservation. The best authority places the date of construction of this fort at about the first century of the Christian era. The builders were rather canny military architects in their way, too, as is shown by the rude *chevaux-de-frise* of rough limestone protecting the approach.

One of the interesting sights of the island is the large number of crude rock monuments (Fig. 13) to the departed, erected along the roads, often miles from the place where the body lies in the dune cemetery on the eastern side of the island.

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[2] T. J. Westropp: A Study of the Fort of Dun Aengusa in Inishmore, Aran Isles, Galway Bay: Its Plan, Growth, and Records, *Proc. Royal Irish Acad.*, Vol. 28, 1910, Sec. C., pp. 1–46; reference on pp. 1–2.

The Inhabitants

The metropolis of the island is the village of Kilronan where the post office, the two stores, the two public houses, and the church are located. This village has also the only wharf on the three islands; only the smallest steamers can tie up to it. Synge describes it as so changed by the fishing industry developed by the Congested Districts Board that it now resembles any fishing village on the west coast of Ireland.[3]

General health conditions are not of the best, although some of the people live to an extended age. The writer attended a funeral there at which the deceased was eighty-four years old, and his godmother was one of the chief mourners. In such a damp climate tuberculosis, pneumonia, and rheumatism are the principal diseases. The recent influenza epidemics naturally wrought great havoc.

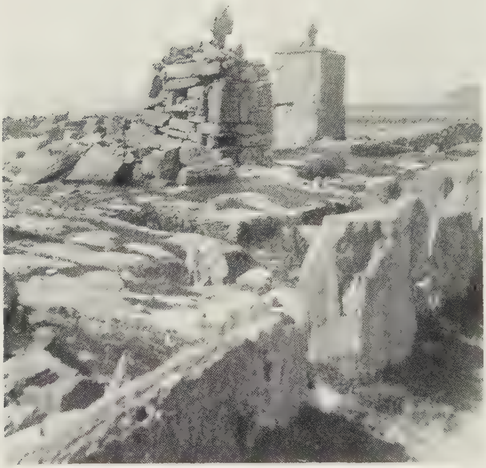

Fig. 13—Memorials to the dead. The deceased may have been lost at sea or buried in the cemetery several miles away, but these monuments line the roads.

The people are sturdy, industrious, hospitable, and honest. They speak Gaelic among themselves, but most of them have English for the stranger. There is seldom any crime among the islanders except the occasional manufacture of poteen or moonshine whisky. Little need be added to Synge's summary:

> It is likely that much of the intelligence and charm of these people is due to the absence of any division of labour, and to the correspondingly wide development of each individual, whose varied knowledge and skill necessitates a considerable activity of mind. Each man can speak two languages. He is a skilled fisherman, and can manage a curagh with extraordinary nerve and dexterity. He can farm simply, burn kelp, cut out pampooties, mend nets, build and thatch a house, and make a cradle or a coffin. His work changes with the seasons in a way that keeps him free from the dulness which comes to people who have always the same occupation. The danger of his life on the sea gives him the alertness of the primitive hunter, and the long nights he spends fishing in his curagh bring him some of the emotions that are thought peculiar to men who have lived with the arts.[4]

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[3] J. M. Synge: The Aran Islands, Boston, 1911.

[4] *Ibid.*, pp. 153–154.

REGIONS OF INTERIOR-BASIN DRAINAGE

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[With separate map, Pl. II, facing p. 414]

THE extent and hydrography of the land areas in the world served by interior basin drainage are of interest to all students of earth science. The physiographic relations of a third of the lands would be changed if precipitation everywhere found its way to the oceans, as is the normal condition in most inhabited regions. In the physical economy of the globe one may consider as two separate domains the regions of interior and the regions of oceanic drainage. It is convenient to describe each of these two great regions by a single word: we may term through-flowing, or ocean, drainage "exoreism" (ex-o-rē-ism, from the Greek ἐξ, out, and ῥεῖν, to flow), interior basin drainage "endoreism" (en-do-rē-ism, from ἐν, in, and ῥεῖν).[1] In this paper we shall attempt to define the extent of the endoreic, or interior-basin, domain and explain its causes. The deserts are *par excellence* the domain of interior-basin drainage, or endoreism. But they present a particular case where run-off is nil and for which the term "areism" is proposed (a-rē-ism, from α, privitive, and ῥεῖν).

Early Work on the Problem

Richthofen[2] distinguished between the peripheral and the central regions of Asia, the latter marked by an arid climate and interior-basin drainage. The first and, up to the present, the only attempt to represent cartographically the extent and disposition of interior-basin drainages is in Berghaus' Physikalischer Atlas, Plate No. 16, 1891, which has been reproduced in divers other works. John Murray, in a paper read before the Royal Society of Edinburgh on Jan. 17, 1887, gave the first estimate of the inland drainage area.[3] He placed it at about a fifth of the land surface, or 11,486,350 square miles, a figure only a little less than that of the arid regions (12,200,000 square miles), or regions of annual rainfall under 10 inches. His calculation was made on an equal-area projection on which were superlaid the boundaries of the interior-drainage basins according to Berghaus. In his admirable monograph on Lake Bonneville[4] G. K. Gilbert, also following Berghaus, gives values for the continents thus: Australia, 52 per cent; Africa, 31; Eurasia, 28; South America, 7.2; North America, 3.2.

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[1] Emmanuel de Martonne: Aréisme et Indice d'aridité, *Comptes Rendus de l'Acad. des Sci.* [*de Paris*], Vol. 182, 1926, pp. 1395–1398.

[2] Ferdinand von Richthofen: China: Ergebnisse eigener Reisen und darauf gegründeter Studien, (5 vols., Berlin, 1877–1912), Vol. 1, p. 7.

[3] John Murray: On the Total Annual Rainfall on the Land of the Globe, and the Relation of Rainfall to the Annual Discharge of Rivers, *Scottish Geogr. Mag.*, Vol. 3, 1887, pp. 65–77.

Penck's "Morphologie,"[5] so rich in numerical estimates, gives figures for the "Binnengebiete" as 22.1 for the continents as a whole, or 29,900,000 square kilometers, of which Europe has 1.6; Asia 12.6; Africa 9.6; Australia 4; North America 0.9; South America 1.2. All these have been calculated on the basis of the Berghaus map: there appear to have been no attempts to improve on this generalization. Penck and Murray note the zonal disposition of the interior drainage and its connection with climate. Neither concerns himself with the Caspian Sea. G. K. Gilbert alone seems to have envisaged the complexity of the problem. Since the publication of Berghaus' map our knowledge of the earth's surface has progressed enough to permit of more precise representation of the endoreic domain and of delimitation of the areic domain—a distinction that has not been attempted before.

METHOD OF WORK

From the standpoint of hydrologic records it is unfortunate that regions of interior-basin drainage are in general but little inhabited. The great modern states lie in regions of normal or through-flowing drainage. The United States is the chief exception: the extent of the interior-drainage basins of the West is exactly known. We are also fortunate in having figures for the basins of the old Russian Empire from the Baltic to the Pacific.[6] With such data in hand, however, the question is not always solved. It often happens that in the higher parts of a basin there is flow, permanent or temporary, which does not attain base level. The hydrographers who measure the area of each basin are not concerned with this distinction, for us essential. The inverse case is also known. A river abundantly fed from its sources may in its lower course traverse a desert, which should be included in the endoreic or perhaps the areic domain. The Nile is an alien feature of the Libyan Desert; it does not receive a drop of water therefrom but, on the contrary, loses a great part of its volume. The same is the case with the Sir Darya and Amu Darya in Russian Turkestan. Our predecessors have not taken account of these facts. The entire Nile basin is included in oceanic drainage on Berghaus' map and in the calculations of Murray, Gilbert, and Penck. Whence arises a serious error in the results as a whole. Thus even where the surfaces of the hydrographic basins have been exactly delimited and measured we have been obliged to repeat a part of the work; but in most cases the results had to be built up basin by basin through original studies.

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[4] G. K. Gilbert: Lake Bonneville, *U. S. Geol. Survey Monograph No. 1*, 1890.

[5] Albrecht Penck: Morphologie der Erdoberfläche (2 vols., Stuttgart, 1894), Vol. 1, p. 189.

[6] Jules de Schokalsky and A. de Tillo: Superficie de la Russie d'Asie, avec les bassins des océans, des mers, des rivières et des lacs, St. Petersburg, 1905, French text, 1907. See also Jules de Schokalsky: La comparaison des mesures de superficie, de l'Asie Russe et de ses bassins, *Atti X Congr. Internaz. di Geogr., Roma*, 1913, Rome, 1915, pp. 642-651.

The accompanying map of the endoreic and areic regions has been the object of a series of studies prosecuted during some ten years by the students at the Institut de Géographie of the Sorbonne under the direction of M. de Martonne. Maps of the continents or parts thereof have been drawn up on scales ranging from 1 : 1,000,000 to 1 : 6,000,000. Use has been made of all cartographic documents in the collections of the Institut, which numbers about 35,000 sheets, in particular of the sheets of the millionth map of the world and of all the maps covering considerable territory on this scale. The work, however, might not have been accomplished even yet if, after five years of interruption (1914–1919), there had not been available the devoted collaboration of L. Aufrère, who has had charge of the editing of the world map on the scale of 1 : 20,000,000. This work has included complete and detailed revision, all doubtful points being referred to the original documents.[7]

The difficulties arise in part from the unequal value of the source material, in part from the indefiniteness inherent in the limits themselves. The boundary between the endoreic and the exoreic regions can be drawn without hesitation, granted the accuracy of the maps used; it is different, however, with areism. Only on maps of scale not less than 1 : 100,000 with the detail and precision of regular surveys can the boundary of areism be recognized; and it is a zone rather than a line, a zone fluctuating from year to year with variations in climate.

In principle we include in the areic regions all areas that do not originate rivers that reach the sea either directly or through flow into some other stream. A river crossing the region without rising therein does not change the areic character, as was pointed out above. Regions of intermittent streams are not included in the areic domain provided the streams flow at some time in every year, if only for a few days. The maps do not always enable us to decide this point: yet on scales larger than the millionth, if well executed, they give certain unmistakable indications if degradation of the hydrographic network is in progress. A stream channel that is not utilized will not keep continuity of gradient; it broadens in section, a succession of hollows appears, obstacles such as a barrier of dunes choke the valley. Such characters are easily observed in the lower courses of great wadis of the Sahara descending from the Atlas or the Ahaggar[8]. Among extreme forms of degradation may be noted the torrential character of stream flow in the desert observed on the mountain borders, as in the Arabian desert east of the Nile and in the Tassili of the western Sahara. The torrent beds are well enough defined, but often they remain without water for several years. An occasional heavy rain launches a flood known as *séil*,[9] similar to the *lave* of the alpine torrents, which carries all before it but lasts only a short time and generally does not reach the end of the valley. Such a régime is revealed on a good map by the absence of the regular network of stream channels. The effects of heavy downpours are shown in sheet flood erosion as described by McGee[10] and in excessively broadened river beds passing to the form of the wadi. The piedmont waste descending towards the center of the basin is furrowed by dry discontinuous channels. Such inundation may extend over immense distances at the foot of the mountains enclosing interior basins. Good examples may be seen on certain sheets of the West of the United States and southern Algeria.

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[7] In consequence of this revision the figures differ somewhat from the earlier calculations given in: Emmanuel de Martonne and L. Aufrère: Extension du drainage océanique, *Comptes Rendus de l'Acad. des Sci.* [*de Paris*], Vol. 180, 1925, pp. 939–942, and Emmanuel de Martonne: Extension des régions priveés d'écoulement vers l'océan, *Compte Rendu Congr. Internatl. de Géogr.*, Cairo, 1925, Vol. 3, pp. 25–50. The diagrams of percentage of areism and endoreism also have been based on a new method which better permits comparison with the index of aridity: zonal values have been transformed to linear values.

Even in a rapid survey one cannot fail to notice areas thickly sprinkled with unconnected lakes. It is an imperfect form of areism, which we may term "humid" areism, frequently seen in plains where a rainy season occurs too short to permit organization of drainage. Such may be noted in Senegal and the Sudan, where one speaks of "winter lakes," in Turkestan, on the edge of the Karroo, etc. The number and extent of these bodies of water vary from one season to another; so that the reconnaissance maps give very different pictures of the country according to the time when they have been made.

It is obvious that the work on our map has necessitated a rational interpretation of cartographic documents of very unequal value. To supplement the maps use has been made of meteorological data, of scientific results of explorations, and of travel narratives.

The influence of the nature of the ground has also to be considered. Limestones and permeable sands, sandstones, even recent basalts, loess in sufficient thickness may produce artificial effects as in the karst of Dalmatia. Permeability of soil really deserves a special study in both arid and semiarid regions. Central Yucatan, where rainfall reaches 800 millimeters, would probably enjoy a temporary run-off, though probably not a regular run-off, if the subsoil were not a limestone.

THE CALCULATION

Measurement of the surface areas has been made according to the method that gives the highest degree of accuracy within the scope of the problem. Our original on the scale of 1 : 20,000,000 has been carried out on a base map by Eckert, which has a complete network of meridians and parallels by degree units. We counted for each continent the number of whole units (trapeziums) and estimated the value of the fractions in each latitudinal zone in the endoreic and areic domains. The total obtained was multiplied by the area of a trapezium by degrees given by tables for the spheroid. Adding the values by zones gave figures by continents, hemispheres, and for the globe as a whole.

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[8] E. F. Gautier: The Ahaggar: Heart of the Sahara, *Geogr. Rev.*, Vol. 16, 1926, pp. 378–394.

[9] W. F. Hume: Geology of Egypt, Vol. 1, Survey of Egypt, Cairo, 1925, p. 85.

F. Foureau: Ma mission de 1893–1894 chez les Touareg Azdjer, Paris, 1894.

[10] W J McGee: Sheetflood Erosion, *Bull. Geol. Soc. of Amer.*, Vol. 8, 1897, pp. 87–112.

This method, formerly employed by Schokalsky for measuring the basins of the Russian Empire, appears to us well designed for all areal measurements on the continents and especially for such as concern the whole of the globe. It avoids the corrections which must be applied to planimetric methods or measurements by weight. It is applicable, furthermore, to maps on other than the equal-area projection; for the only surfaces directly measured are very small, fragments of a degree trapezium, and here it is a matter of the proportion and not a direct measure. The method has the additional advantage of giving figures by zones of latitude permitting the examination of several interrelations of phenomena, particularly of climate.

Results of the Study As a Whole

According to our map the entire surface having interior-basin drainage covers nearly 42,000,000 square kilometers, to be precise 41,838,000, rather more than a quarter (27 per cent) of the total land surface of the globe, a third (33 per cent) if the polar lands are excluded, as we shall exclude them from the following discussion. These figures surpass previous estimates. The difference is not due simply to a greater precision in execution but to a more exact definition of the interior-drainage basins.

Of the 41,838,000 square kilometers without drainage to the sea (endoreic domain) 27,991,000 only appear to be entirely without run-off; in other words the areic domain accounts for 17 per cent of the total land surface, 23 per cent if the polar regions be omitted.

We may now stop to consider the importance of these results. It is significant that on 23 per cent of the continents evaporation exceeds precipitation and that on 11 per cent of the remainder the rains are insufficient to assure flow to the ocean under the present conditions of relief; so that on 33 per cent of the surface the meteoric waters, abstracted for the most part from the surface of the sea, do not return there. It must be concluded that extension or reduction of endoreism would have as consequence a lowering or a raising of the level of the sea and thus cause important changes in the shore lines. Precipitation is not abundant in regions of interior drainage; the index of run-off, zero in the areic domain, rarely exceeds an average of 10 centimeters in the endoreic domain. Nevertheless with a surface of 14,000,000 square kilometers there would still be a volume of 1400 cubic kilometers escaping to the oceans each year—a value corresponding to a lowering of sea level of 0.47 meters a century. There is a unity in the earth's hydrography which justifies, in a measure, the expression hydrosphere.

From the point of view of continental morphology the endoreic and areic domains exhibit abnormality. The law of the common base level is not applicable to a third of the lands. The proportion would be still greater if exception were made of those parts of America and Eurasia where the ground is frozen to a depth; perhaps it would attain 40 per cent. As the endoreic domain is unable to export its waste, the interior basins tend to fill up with progressive raising of the base level offset in some instances, of course, by exportation of desert dust to extradesert regions.[11] This has a bearing on sea level, difficult, however, of numerical expression. All available estimates of denudation are based on observation in the exoreic regions. L. W. Collet[12] gives 57 millimeters as the mean lowering of surface per century for the northern slopes of the Swiss Alps. Reducing this to one-third, a total of 3 cubic kilometers of material a century is kept back from marine sedimentation by the fact of interior-basin drainage. The raising of sea level that would result from complete removal of waste to the sea is small in comparison with that which would be produced by the return to the sea of the endoreic waters (3/100), yet it is not negligible. Finally, if isostatic equilibrium is not an idle expression, the displacement of material of erosion must affect it; and one cannot doubt that it would be sensible to a change in the extension of endoreism. The surface area of terrigenous sediments is estimated at 73,000,000 square kilometers; the 3 cubic kilometers of sediments remaining in the interior basins would, on this surface, be equivalent in a century to a layer 17 meters thick, disregarding the effect of settlement. In weight, and accepting Collet's figure of 1.5 for mean density of sediments, it would represent a load of 4.5 milliard tons, or 26 tons per square meter.

VARIATION ACCORDING TO LATITUDE

The method that permits us to calculate the total area of the endoreic and areic domains gives us a means of showing the variations of their latitudinal extent calculating the proportion for each degree zone. Table I gives these numerical values graphically shown in Figure 1. The irregularities of the curve need not prevent us from arriving at some general conclusions. Disregarding anomalies such as rise from the varying and dissimilar distribution of land and water in northern and southern hemispheres, the general trend of the curve is clear enough: oceanic drainage, or exoreism, dominates in the high latitudes and in the equatorial zone; its minimum extension in both hemispheres is about the tropic but is better displayed in the northern hemisphere. The continental hemisphere also is that in which endoreism is most extended, having about three-quarters of the domain (32,000,000 square kilometers).

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[11] Siegfried Passarge: Die Kalahari: Versuch einer physisch-geographischen Darstellung der Sandfelder des südafrikanischen Beckens, Berlin, 1904.

W. M. Davis: The Geographical Cycle in an Arid Climate, *Journ. of Geol.*, Vol. 13, 1905, pp. 381–407.

Erich Kaiser: Die Diamentwüste Südwest-Afrikas, 2 vols., Berlin, 1926.

[12] L. W. Collet: Les lacs: Leur mode de formation, leurs eaux, leur destin, Paris, 1925.

The curve of percentage of areism is close to the zero line on 25 degrees in low latitudes, it returns there from the 55th parallel in the northern hemisphere and the 50th in the southern hemisphere. Its ups and downs in the southern latitudes between the 40th and 50th parallels are as erratic as those of the endoreic curve and need not claim our attention here.

The explanation of the variations of percentage in the endoreic and areic regions according to latitude must be sought for in the climatic factor. We have already noted the vital importance of precipitation and temperature. The zonal means of these phenomena have been deduced from meteorological maps and may be compared with the percentages of endoreism and areism by calculating in round numbers the percentage for corresponding parallels.[13] It appears that the curve of endoreism follows that of temperature in the temperate zone, that of rainfall in the warm zone. This is as would be expected; in middle and high latitudes the variations of temperature are much greater than that of the rains, whereas in low latitudes the temperature variations are small. The extent of interior drainage appears to be reduced to a minimum when mean annual precipitation exceeds 1200 millimeters, whatever the temperature, and when the mean temperature falls to 0° C., however deficient the precipitation. Yet it should be noted that the relations are not the same in the two hemispheres. Furthermore, the minimum towards the equator does not correspond with a rainfall maximum: it lies at about the 10th parallel in the southern hemisphere.

The Index of Aridity

If the action of temperature is preponderant in the high latitudes and that of precipitation in the low latitudes these two influences act everywhere, and it appears desirable to find some means of expressing their combined function. After several attempts we believe a satisfactory combination has been found, and we call it the "index of

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[13] Martonne, Traité de Géographie physique, 4th edit., Vol. 2, 1926, p. 940.

TABLE I—EXTENT OF ENDOREIC AND AREIC REGIONS BY LATITUDINAL ZONES

(Expressed by area in 1000 square kilometers and as percentage of total land area)

LATITUDE	NORTHERN HEMISPHERE				SOUTHERN HEMISPHERE			
	ENDOREIC		AREIC		ENDOREIC		AREIC	
	AREA	PER CENT	AREA	PER CENT	AREA	PER CENT	AREA	PER CENT
0	74	7	61	6	43	4	28	3
1	120	13	74	8	55	5	30	3
2	135	15	74	8	49	5	18	2
3	135	15	61	7	59	5	10	1
4	107	11	61	6	66	6	6	1
5	98	10	49	5	49	5	12	1
6	159	16	61	6	29	3	10	1
7	195	18	55	5	45	4	8	1
8	218	19	36	3	33	3	9	1
9	250	23	54	5	15	2	14	2
10	261	25	78	8	8	1	8	1
11	289	31	91	10	4	0.5	4	0.5
12	370	38	147	15	18	2	11	1
13	437	42	326	31	41	5	13	1
14	612	56	447	41	68	7	19	2
15	653	59	511	46	111	11	23	2
16	707	64	640	55	124	12	31	3
17	776	63	712	58	241	24	91	9
18	821	62	771	58	382	38	170	17
19	843	64	770	59	453	47	266	27
20	859	65	803	61	522	51	375	37
21	858	61	803	61	567	55	333	32
22	863	59	801	55	530	51	268	26
23	836	57	768	52	551	55	311	31
24	822	57	788	54	539	56	370	39
25	859	56	799	52	501	56	354	40
26	847	54	764	49	507	58	328	37
27	931	58	828	52	504	58	323	37
28	924	57	769	48	488	58	406	48
29	954	58	743	45	494	61	398	50
30	1040	61	751	44	483	63	386	50
31	920	57	642	40	379	54	279	40
32	813	52	422	27	265	44	183	30
33	654	44	329	23	212	40	161	31
34	606	40	292	19	158	44	96	27
35	593	39	188	12	127	44	80	27
36	592	39	188	12	119	44	55	20
37	686	46	309	21	89	33	30	11
38	740	50	393	27	48	23	19	9
39	690	46	461	30	57	42	29	11
40	729	47	538	34	56	44	28	22
41	729	48	452	30	46	34	18	13
42	700	46	468	31	50	39	36	28
43	743	47	547	35	45	41	43	39
44	720	46	572	36	44	42	33	32
45	709	44	582	36	35	37	11	12
46	736	45	553	34	25	34	20	27
47	636	37	413	24	34	48	30	42
48	505	29	257	15	36	52	28	40
49	400	24	179	11	28	44	24	38
50	298	18	134	8	16	35	12	26
51	245	15	85	5	3	6	3	6
52	259	16	83	5	1	3	1	3
53	304	19	103	6				
54	317	22	115	8				
55	293	21	98	7				
56	202	15	12	1				
57	185	14	10	1				
58	165	13	4	0.3				
59	112	9	3	0.2				
60	43	3						
61	9	1						

aridity," Ar $= P: (T + 10)$, T representing the mean annual temperature in degrees centigrade and P the annual precipitation.[14] The establishment of an arbitrary zero at $-10°$ C. is based on two considerations: endoreism is unknown in regions having an annual mean temperature lower than this; in most of these regions the ground remains frozen at a depth the year round, giving rise to abnormal conditions of circulation.

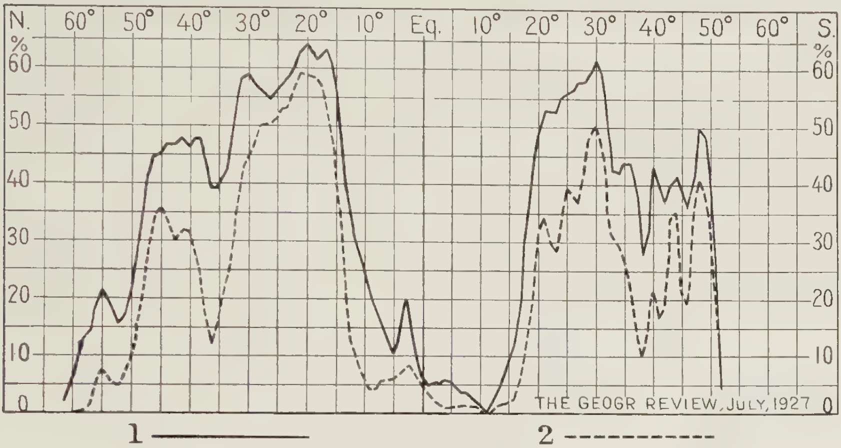

FIG. 1—Areas of the endoreic and areic domains in relation to the total area of the lands by degree zones of latitude. The endoreic domain is shown by a solid line, 1; the areic domain by a dashed line, 2. Compare Table I.

We still have to set forth a correction of T calculated by the meteorologists, for we apply it to continents alone. T in our formula represents a zonal mean newly calculated for this purpose after Hann's isotherms.[15]

A glance at Figure 2 shows us that the curve of the index of aridity follows faithfully that of endoreism and areism. It has the same points of inflexion, save the equatorial minimum, and values comparable in the two hemispheres (excepting the high latitudes of the southern hemisphere). The arid zone is farther from the equator in the southern hemisphere and is more reduced. It is at about the 30th parallel in the southern hemisphere that the maximum of endoreism as well as of areism is found, whereas in the northern hemisphere it lies at about the 20th parallel; and these latitudes correspond to minimum values of the index of aridity. As a whole we can say that exoreism is at a maximum for values of Ar above 35 and at a minimum for values below 20; the limit of areism corresponds about to 10.

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[14] Emmanuel de Martonne: Aréisme et indice d'aridité, *Comptes Rendus de l'Acad. des Sci.*, [*de Paris*], Vol. 182, 1926, June 7, pp. 1395–1398.

[15] Julius von Hann: Atlas der Meteorologie, forming Part III of Berghaus' Physikalischer Atlas, Gotha, 1887.

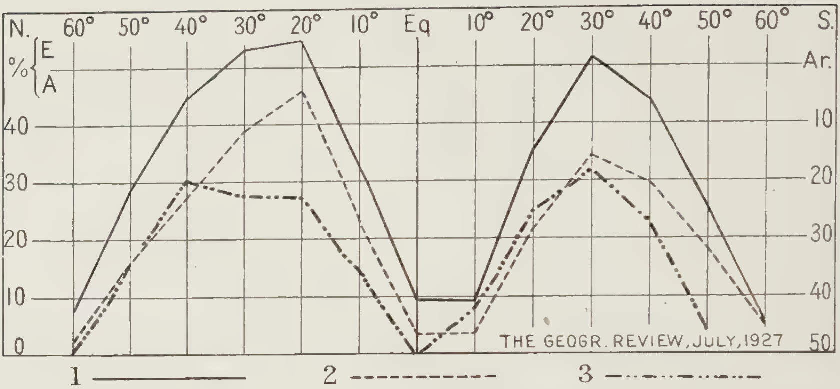

FIG. 2—Extent of the endoreic and areic domains compared with the index of aridity by 10-degree latitude means. Endoreism is shown by solid line, 1; areism by a dashed line, 2, with scale of percentages on the left: the index of aridity is shown by dot-and-dash line, 3, scale on right.

The value of the index of aridity can be checked by calculations for a certain number of points in critical areas: in such case it is understood that the mean temperatures are not reduced to sea level. In the areic regions we invariably find indices below 10, reaching scarcely 1 or 2 in the most typical deserts. Thus in the Sahara 6 at Laghwat, 2 at El Golea, 5 at Tozeur; in Russian Turkestan 3 at Khiva, 5 at Merv; in the center of Australia 4 at Strangways Springs; in the deserts of the west of the United States 2 at Yuma; in those of South America 2 at Lima and 1 at Copiapó. Between the limits of areism and endo-

TABLE II—PERCENTAGE OF ENDOREISM (E) AND AREISM (A) COMPARED WITH INDEX OF ARIDITY (AR)

(By 10-degree means)

LATITUDE	WORLD AS A WHOLE			EASTERN OLD WORLD			WESTERN OLD WORLD			NEW WORLD		
	E	A	AR	E	A	AR	E	A	AR	E	A	AR
60 N.	8	2	50	7	5	55	20	0	35	1	0	75
50 "	28	16	34	45	32	25	30	6	40	7	2.5	47
40 "	44	27	20	65	40	15	41	25	21	17	7.5	30
30 "	53	39	17	35	19	25	80	65	5.6	26	18	27
20 "	54	46	17	8	5	36	86	75	7.6	18	13	28
10 "	33	23	35	0	0	48	49	34	31	2.5	1	41
0	9	3	51	0	0	67	18	6	39	0	0	58
10 S.	9	4	42	12	4	53	16	6	36	4.5	2.5	45
20 "	35	22	25	53	31	15	28	17	20	21	13	38
30 "	51	34	18	72	52	12	23	17	17	39	21	32
40 "	44	30	27	30	26	47	(5)	(4)		49	28	21
50 "	25	18	46							32	22	43

reism the indices vary between 10 and 20; for example in Asia, Samarkand 14, Semipalatinsk 15, Peshawar 10; in North America, Salt Lake City 17, Winnemucca 11; in South America, Salta 17.

These examples bring us to an attempt to show the value of the index of aridity on a map for the continents as a whole. About 200 stations conveniently chosen permit the drawing of curves for indices of 5, 10, 20, 30, and 40 (Fig. 4). Comparison with the map of interior-basin drainage shows in general a remarkable correspondence between the limits of areism and the 5 Ar line which appears to enclose the true deserts. The curve of 20 is less faithful to the limit of endoreism which is often determined by relief, notably in Asia. But beyond the index of 30 drainage is everywhere organized to the ocean with the exception of the Volga, whose waters flow to the greatest inland sea, the Caspian.

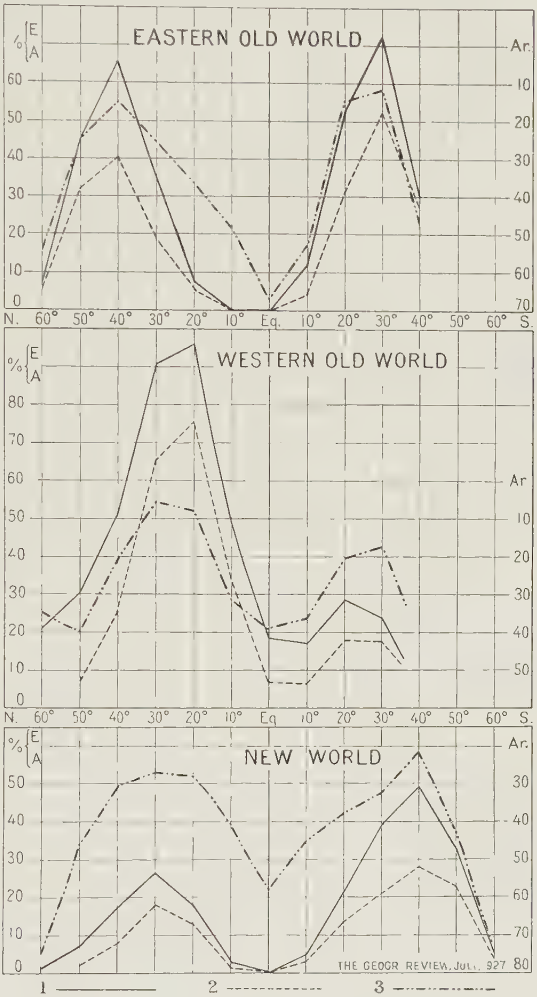

FIG. 3—Extent of the endoreic and areic domains compared with the index of aridity for the three continental spindles. Endoreism is shown by solid line, 1; areism by dashed line, 2, with scale on left: the index of aridity is shown by dot-and-dash line, 3, with scale on right. Compare Table II.

It appears, then, that we have in the index of aridity a climatic function of great value for explaining conditions of drainage. Its geographical significance is still broader. Such a combination of temperature and rainfall explains the character of the vegetative cover much more adequately than rainfall alone. It seems that indices below 5 characterize the true deserts from the botanical as

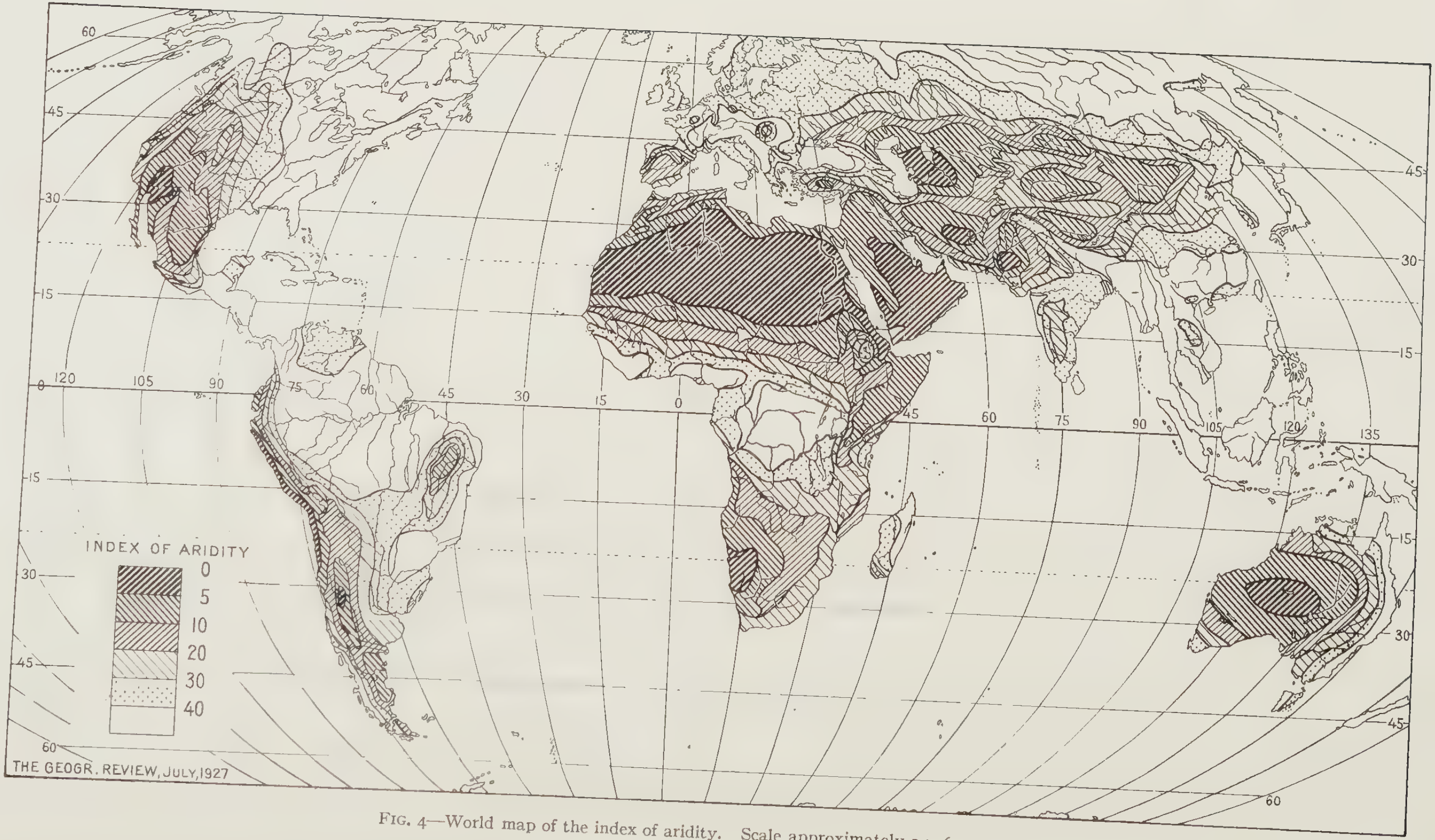

FIG. 4—World map of the index of aridity. Scale approximately 1 : 160,000,000

well as the hydrographical point of view; indices about 10 correspond with the dry steppes; those of 20, more or less, to the prairies; above 30 forest vegetation tends to predominate and gains complete control of the soil where the index exceeds 40 provided that the temperatures are not too low. The relation with agricultural possibilities may also be noted. No cultivation is possible without irrigation where the index of aridity is below 10; between 10 and 20 is the domain of dry farming. Applications of the index of aridity have been developed elsewhere.[16] It has the advantage[17] of requiring only two sets of meteorological data whose values are known for almost the entire globe.

Figures for the Continents[18]

We shall now consider the distribution of interior-basin drainage according to the major divisions of the land surface of the world. We may first group the continental masses into three spindles: (1) the New World, the Old World divided into (2) Western and (3) Eastern sections by the Urals, the Caspian Sea and Persian Gulf, and the 50th meridian (Table II and Fig. 3).

The New World is the best drained; outside of the tip of South America no zone has more than 40 per cent interior drainage. Accordance with climatic conditions as synthesized by the index of aridity is marked. The Western and Eastern spindles of the Old World present contrasts. The former exhibits in the northern hemisphere the highest proportions of endoreism and areism in the neighborhood of the tropics and the lowest about the 40th parallel, whereas the Eastern spindle shows the greatest extension of oceanic drainage in the low latitudes. In this spindle the great extent of areism outside the tropics in the southern hemisphere (in Australia) is noteworthy. Clearly it is the Western spindle of the Old World that is responsible for the asymmetry of the curve of endoreism for the world as a whole, this spindle being the only one where the equatorial minimum lies at 10° S. This peculiarity is not reflected in the index of aridity, but we may inquire as to whether we are sufficiently well informed on the climate of equatorial Africa.

North America is the best-drained continent, the endoreic and areic domain being there reduced to 10 per cent, 2,136,000 square kilometers. This is not surprising, considering the high values of the index of aridity for all latitudes. Climate, then, is the chief cause here.

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[16] Emmanuel de Martonne: Une nouvelle fonction climatologique: l'Indice d'Aridité, extract from *La Météorologie*, October, 1926.

[17] Compare D. Szymkievicz: Études climatologiques, *Acta Soc. Botan. Poloniae*, Warsaw, 1923, 1925. Compare also Dr. Paul Hirth's recent attempt at combining temperature and rainfall, "Die Isonotiden," in *Petermanns Mitt.*, Vol. 72, 1926, pp. 145–149, discussed (with maps) by Mark Jefferson in the April number of the *Geogr. Rev.*, pp. 335–338.

[18] Lack of space prevents inclusion here of a section by L. Aufrère, discussing individually the more important basins of interior drainage. In a special reprinting of the paper this section is included as an appendix and may be obtained on request.—Edit. Note.

But it should be noted that nearly half the continent lies north of the 45th parallel, that is in a zone where endoreism is almost unknown. The endoreic domain is scarcely more extended than that of the areic and is strictly limited to the west. This is not only because of the orographic structure, which is as unfavorable to run-off to the Pacific as it is favorable to the Atlantic: the climate is as dry in the one as it is humid in the other. The map shows the index of aridity dividing the United States into two halves, the one to the east where Ar is everywhere above 30 and even exceeds 40 between the Mississippi and the Atlantic, the other below 30 and even below 20 over the entire extent of the dry Rockies and the Great Basin.

It is perhaps surprising that South America is not so well drained as North America, in spite of the enormous rainfall of the great Amazon basin—so admirably organized, it would seem, for regular run-off. The per cent of endoreism (14) is raised by the aridity of the continent south of 30° S.

South America, however, is better drained than Europe, where one expects a better organization of the run-off. If the endoreic domain occupies 24 per cent of Europe (2,205,000 square kilometers) areism is almost unknown. In reality the anomaly is due to the northward extension of the Volga basin, tributary to the Caspian. The greatest part of this basin has indices of aridity comparable to those of France (Samara, 27; Kazan, 30), but the slope leads the waters into an interior basin too broad and deep for overflow and enclosed by areic plains (Astrakhan, 7).

Asia, Africa, and Australia are continents where drainage is less perfect. A high proportion of their areas is in latitudes about the tropic; and their structures are massive, without coastal articulations as in western Europe, without great open plains like the Amazon and Mississippi basins. Interior depressions due to faulting or warping are numerous and everywhere create systems of slopes converging towards closed basins that could drain towards the ocean only if the climate were very humid.

Australia has the record for endoreism, 64 per cent, and for areism, 43 per cent. It is the only continent traversed centrally by the tropic. Its relief is nowhere sufficiently important to favor precipitation save on the eastern coast; but if the Australian Alps favor the littoral over which they look it is to the detriment of the plains stretching westward.

Nearly half of Africa drains towards the ocean: the endoreic domain amounts only to 52 per cent, the areic to 40 per cent. The reason is that a large part of that continent lies in the equatorial zone. The Congo basin is apparently a closed basin that has overflowed. The case is the same with the Zambezi and the Niger. Among the tectonic depressions of eastern Africa those lying in sufficiently rainy regions have maintained their outlets; the others are isolated, their centers being occupied by lakes, some of them saline.

Asia is the most interesting continent hydrographically. The percentage of interior-basin drainage is lower than that of Africa, although it includes 14,847,000 square kilometers, or 35 per cent of the total endoreic domain. All monsoonal Asia has oceanic drainage with indices of aridity above 40. The great plains of Siberia for the most part have regular drainage, having indices of over 35 and 40. The principal area of endoreism is found in latitudes where elevation is very great. The reason is to be sought in the numerous tectonic depressions whose size demands a humid climate for the maintenance of through drainage, whereas the climate is dry because the mountains cut off the rainy winds. Observations are lacking for the calculation of indices of aridity in the greater part of these regions; we only know that it falls below 10 in Russian Turkestan (Merv, 5; Kasalinsk, 6; Irgis to the north of the Aral, 11).

TABLE III—AREA AND PERCENTAGE OF ENDOREIC AND AREIC REGIONS BY MAJOR DIVISIONS

(Areas in 1000 square kilometers)

Region	Endoreic		Areic	
	Area	Per Cent	Area	Per Cent
Europe	2,205	24	452	5
Asia	14,847	35	9,935	24
Africa	15,223	52	11,771	40
Australia	4,920	64	3,309	43
North America	2,136	10	1,070	5
South America	2,507	14	1,454	8
Northern Hemisphere	32,386	34	22,139	23
Southern Hemisphere	9,452	28	5,852	17
World	41,838	33	27,991	23

SOME EXCEPTIONS TO LATITUDINAL ZONING

Having examined the most striking feature of distribution of interior-basin drainage we may now inquire into some of its numerous irregularities. Along the equator oceanic drainage is the rule, as interior drainage is along the tropic. Yet there are exceptions. The most important is in eastern Africa. From Eritrea to Nyasa stretches a belt where endoreism and even areism prevail. Meteorological data are lacking, but the vegetation bespeaks true aridity. In northeastern Brazil is an arid region more limited, it is true, but similar in situation to that of the steppes and deserts to the east of Lake Victoria. The extension of aridity to the tip of the Somali country and the seaboard is not matched anywhere, and a really satisfactory explanation has not yet been offered.

The western borders of the continents do not escape aridity in the equatorial zone. South America offers the most striking example with the coast desert of Peru. That the cold Humboldt Current is a contributary cause has been confirmed by the recent incidence of the rains of 1925 and the weakening of the current.[19] South Africa offers an analogous case in the aridity that extends from the mouth of the Orange River almost to the Congo and is associated with the cold Benguela Current.

It is along the tropic that the greatest stretches of endoreism and areism are found: but these zones, which correspond to indices of aridity below 10 or even 5, are not continuous. The monsoonal domain of southeastern Asia has an index of aridity above 40. The Antilles, southeastern North America, and other tropical and subtropical eastern seaboards are also humid.

Beyond the 30th and 40th parallels humidity becomes the rule on the western coasts and endoreism is thrown back into the interior. The southern extremity of South America is divided into a narrow, very wet littoral section on the west and an arid section covering all Patagonia on the east. In North America the prairies show patches of endoreism up to the 55th parallel. In Eurasia areism exists at least to 56° or 57° in the west Siberian plains. The polar limit of areism is systematically advanced under the continental climate in these flat alluvial plains. That of endoreism is advanced still further by exceptional conditions of relief: the waters of the Volga are abundant enough to reach the ocean did not the slope lead them to the greatest closed basin created by deformation on the earth's surface and lying, furthermore, on the borders of a great areic region. With this exception the index of aridity explains the systematic irregularities in the zonal distribution of interior basin drainage. These may be summarized thus: aridity limited to the borders of the equatorial masses of the continents, especially to the western littoral in the southern hemisphere; general aridity along the tropics with the exception of the eastern slopes; westward extension of aridity in the subtropical zone; aridity confined to the continental interiors towards the poleward limit of areism. Departures in detail are to be ascribed to the direct influence of relief or of geological structure on stream run-off.

Considerations of conditions as they are today will not explain everything. Relief is affected by crustal movements still in progress in places, and everywhere erosive forces are at work. Nor is climate constant. Hence hydrographic adaptation to conditions as we see them is not perfect. Headward erosion of the systems draining to the ocean threatens the independence of the interior basins, particularly in the endoreic regions where local base level is being raised by sedimentation if not by lake formation. In Africa the basins of the Nile, the Niger, and the Zambezi exhibit the conquest of exoreism over endoreism. Lake Chad is threatened by the Niger. In the rainy season the Benue, a tributary of the Niger, is already tapping the waters of the Logone, tributary of the Shari.

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[19] R. C. Murphy: Oceanic and Climatic Phenomena Along the West Coast of South America During 1925, *Geogr. Rev.*, Vol. 16, 1926, pp. 26–54.

The case of the Nile is curious, for its lower course is through an areic region. The basins of the equatorial region overflow and yield water in abundance, so that erosion of the rock barriers forming the cataracts continues. Probably it was during the humid phases corresponding to the Quaternary glaciations that captures of the interior basins of the upper Niger and the upper Zambezi took place. The Niger was then reinforced by the entire network of fossil wadis of Tafassasset. Erosion of the Victoria Falls is still in full swing on the Zambezi. The Niger has only rapids, no falls, in its course.

As regards evolution of the present drainage in northern Africa French geographers and geologists have rightly protested against Grund's hypothesis of the extension of interior drainage.[20] All indications point to headwater erosion in the basins of the high Algerian-Moroccan plateaus by Atlantic and Mediterranean rivers. But it is probable that the most appreciable gains were made during the humid periods of the Quaternary.

In Asia many conquests of oceanic drainage over endoreism also date from the Quaternary. The Ob captured the Black Irtish and the Zaisan Nor, the Amur and the Liao Ho invaded Manchuria, the Hwang Ho and the Brahmaputra penetrated, the one the Ordos, the other Tibet. Nor has postglacial aridity compromised the situation, thanks to these powerful watercourses. It is certain that communication by the Uzboi existed between the Aral and Caspian Seas during the Quaternary when the level of the former sea was higher: it is even probable that there was an outlet from the Caspian to the Sea of Azov by the Manytsch. The Volga is threatened with capture by the Don: so far it has escaped, owing to the sinking of the water surface of the Caspian, 30 meters below sea level, a lowering which in turn is due to the enormous evaporation under a desertic climate.

These are a few examples of the fluctuating fortunes in the strife between oceanic and interior drainage since the Quaternary. It may be asked if annexation to the exoreic domain always constitutes an advantage. It may be considered so if it occurs in a region anciently endoreic where return to normal conditions leads to the exportation of waste, to the establishment of a regular drainage network, and perhaps to an amelioration of climate, access of winds from the oceans being facilitated. It is not certain that there is climatic or even physiographic advantage in the case of an areic region. The retention of waters as a lake in an arid region, as Chad, Lob Nor, the Aral Sea, is favorable to life; evaporation renders the air less dry, infiltration creates ground-water resources. The Kalahari appears to have lost by the conquests of the Zambezi and the Orange. It is a fact that the life of Bornu depends on the Chad, and Colonel Tilho[21] considers that a great danger threatens these territories in the imminent capture of the Shari by the Benue.

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[20] E. F. Gautier: Sahara algérien (Missions au Sahara, Vol. 1), Paris, 1908.

The development of interior-basin drainage, like other geographical facts, cannot be explained by present conditions alone. Important changes have occurred in the recent past, are in operation now, or are being prepared for in the future. They are of interest to us for the light they throw on the relations of the physical phenomena to which the face of the earth is due. They may have economic consequences to which no one can remain indifferent.

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[21] Jean Tilho: Sur l'ordre de grandeur des variations de profondeur et d'étendue du Lac Tchad, *Comptes Rendus de l'Acad. des Sci.* [*de Paris*], Vol. 180, 1925, pp. 1233-1236.

Idem: Les variations du Lac Tchad, *Bull. Assn. de Géographes Français*, No. 9, May, 1926.

SCRANTON AS AN URBAN COMMUNITY

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[With separate map, Pl. III, facing p. 422]

> YONDER, the noisy water . . . takes a white leap from one of the loveliest and loneliest nooks carved from the mountain, before it splashes on the busy wheel of the manufacturers, and after being used three or four times in its passage through the village, mingles with the waters of the Lackawanna below. . . . the landscape sprinkled with brown colored dépôts, car-shops, and Vulcan's works upon every side; . . . on their passage to New York; . . . the chaste, imposing churches, the long, white lines of public and private architecture contrasting finely with the deep green of the surrounding trees, tastily left for shade; . . the trains of coal-cars, serpentine and dark, emerging from the "Diamond Mines," . . . the villages of Hyde Park, Providence, Dunmore and half a dozen little rosy buds of villages, standing like sentinels at the outposts about to be surrendered; . . . the neat farm-houses here and there nestling in some lovely meadow or half hid among the blossoms of orchards, and the background of the unshorn mountain swelling upwards from . . . the Lackawanna region, all make up a [most impressive] sight. . . . Nor is this all, as he looks into the bosom of "Capouse Meadow," his eye wanders over coal lands which, fifteen years before the completion of a railroad outlet north from the valley, could be purchased for fifteen dollars per acre, and which now are worth $800; and lots which then no respectable man was willing to accept as a gratuity, now readily bring from one to two thousand dollars![1]

Hollister's pleasant description is a picture of Scranton in the middle years of the last century, at a critical time in its history. The future was already forecast, a basis laid for the development that has made Scranton today a unique industrial community, the largest and most metropolitan of all the cities of northeastern Pennsylvania. In the present paper it is proposed to examine these characteristics and briefly to trace their growth.

REGIONAL SETTING

As regards its regional setting Scranton comprises a portion of the dense grouping of population[2] in the highly industrialized Lackawanna-Wyoming Valley, the boundaries of which correspond closely with the limits of the northern anthracite field. The coal field is a long and narrow canoe-shaped basin having an area of 176 square miles, a length of about 50 miles, and a width varying from one to six miles. On both sides the valley is hemmed in by even-crested mountain ridges. An almost continuous array of urban communities stretches from north to south along the entire length of the valley. In fact, more than a hundred square miles of the coal basin are included in incorporated cities and towns; and in traveling from one end of the valley to the other one is seldom outside the limits of some urban community. The entire valley boasts a population of more than 600,000, of whom approximately 160,000 live in Scranton.

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[1] Horace Hollister: Contributions to the History of the Lackawanna Valley, New York, 1857, pp. 132–133.

[2] See the map, Fig. 1, accompanying the article by C. E. Batschelet, "A Picture of Population Distribution in Pennsylvania" in this number of the *Review*.

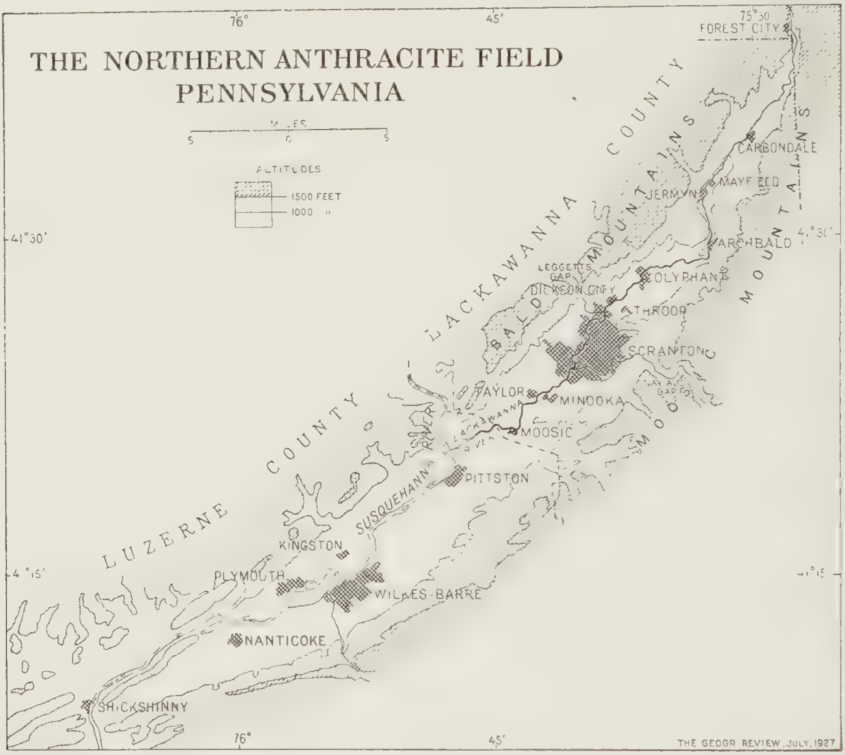

Fig. 1—The northern anthracite field of Pennsylvania. Forest City marks the northeastern end and Shickshinny the southwestern end of the canoe-shaped basin. To the southwest of Scranton the boundaries of the coal basin correspond in general with the 1000-foot contour line, except that almost no coal lies to the west of the ridge extending between Plymouth and Shickshinny, nor do the beds extend into all the small tributary valleys. To the northeast of Scranton the 1500-foot contour line more nearly defines the boundaries of the coal field. Scale of map 1 : 625,000.

Dunmore, although a separate political unit, is considered to be a part of Scranton, for a portion of Dunmore extends almost to the center of Scranton, and the two cities are economically one.

Local Setting and Structure of the City

In spite of the fact that Scranton formerly consisted of several independent settlements, the city is at present a compact community.

The built-up portion extends for a distance of five miles along the Lackawanna Valley and has an average width of about three miles. The city occupies not only the flood plain of the Lackawanna River but also a series of terraces and several minor ridges which, paralleling the river, rise as high as 400 feet above the lowland. When viewing the area from higher vantage points within the city, one is impressed with the pleasing combination of lesser valleys and minor ridges over which the community spreads; but always the higher, tree-covered, mountain ridges (1400 feet above the valley floor), which border the major valley, stand out as the dominating topographic features. Only Nay Aug Gap on the east and Leggetts Gap on the west, like great notches cut into the mountain walls, break the general levelness and continuity of the crests of the bordering ridges. Those well located gaps and a number of fortunately situated antecedent stream valleys afford satisfactory railroad routes across the highland both to the east and to the west of Scranton, and they have had a profound effect upon the establishment and growth of the city.

The expansion of the city has been most pronounced and easiest along the axis of the valley. It is in places difficult to determine just where the boundary lines occur between Scranton and Taylor borough and Lackawanna township on the south, and of Dickson City and Throop on the north. It is not improbable that those four communities, as well as Dunmore, may in the future become parts of political Scranton. In places the city has spread up the lower slopes of the bordering mountain ridges in spite of their restrictive effect upon city expansion. The effect of the ridges upon the plan of the city, its direction of growth, and its compactness is clearly evident (see Fig. 5, p. 422).

The absence of cultivated farm land and market gardens near the city is one of the noteworthy features of the Scranton area. The none-too-fertile soil and the intensity of mining operations cause the Lackawanna Valley to be practically devoid of all types of agricultural activity. Even the small home vegetable garden, so typical in many communities of similar size elsewhere, is seldom to be seen in Scranton.

In most parts of the city the principal streets or avenues extend along the axis of the valley, which is in the direction of the greatest traffic movement. In most parts the longer sides of the blocks extend north and south, which further facilitates the movement of the heaviest traffic. Steep grades occur on many of the cross streets as they ascend to the tops of the minor ridges or rise along the lower slopes of the major valley sides. The Lackawanna River for the entire length of the city interferes with east-west travel. However, a dozen or more bridges enable one to cross the stream along the more important cross streets.

Among the unique features of the urban pattern of Scranton are the large areas of land within the city and along its immediate borders that are occupied by collieries. The breakers themselves with their huge piles of culm, railroad yards, and many associated mine buildings constitute the most striking features of the cultural landscape. Most of the vacant land within the city or immediately surrounding it is likewise owned by coal companies. Nor is that land likely to be released for building purposes until all the underlying coal that can be mined economically has been removed. Most of the city is underlain by several seams of coal, and within each coal bed scores of miles of intricate passageways and innumerable "rooms" have been excavated until each bed resembles a subterranean city.

Scranton as an Industrial Center

Mining has long been Scranton's most important industry, and it has served as the base for most of the city's varied industrial structure. About 15,000 men are employed in the mining industry, and they produce annually about 6,000,000 gross tons of coal.[3] Approximately one-tenth of all the anthracite produced in the United States has been mined in Scranton. A number of environmental conditions made practical the development of this large-scale industry. The coal basin has a greater width and the seams a greater thickness at Scranton than anywhere to the north or immediately to the south.[4] Furthermore, the coal basin at Scranton is in the form of a broad and shallow trough, and the coal beds have not been subjected to serious folding or faulting. Those conditions have made it possible to recover large amounts of high-quality coal with relatively simple and inexpensive mining methods.

At Wilkes-Barre the coal basin again widens and deepens notably, which in part accounts for the development there of the second largest city in the anthracite region. The mining of coal in that portion of the basin is made somewhat difficult, however, because of the greater depth of many beds, the thicker covering of water-logged alluvial material, and the greater structural complexity of the basin.

The principal industrial districts of Scranton occupy the lower portions of the city, especially the lowlands along the five-mile stretch of the Lackawanna River. They also extend into the minor valleys of Keyser Creek, Roaring Brook, Leggetts Creek, and Stafford Meadow Brook. Railroads could be constructed in the valleys with least difficulty. Chiefly because of the large areas of suitable land available there, and in order to secure direct railroad connections, all of the

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[3] State Bureau of Statistics and Information, Harrisburg; and Pennsylvania Department of Mines.

[4] James Macfarlane: The Coal-Regions of America: Their Topography, Geology, and Development, New York, 1873, p. 49.

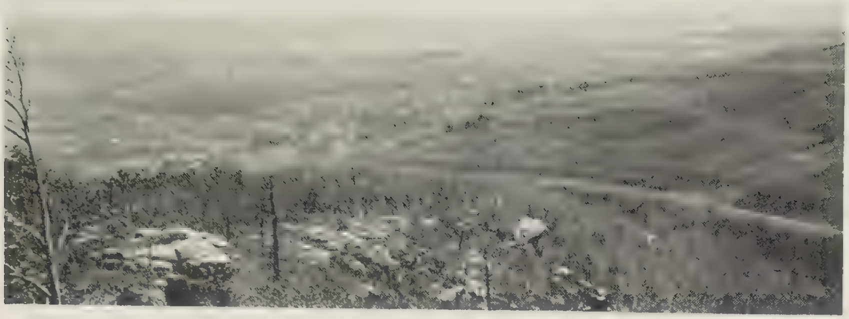

FIG. 2

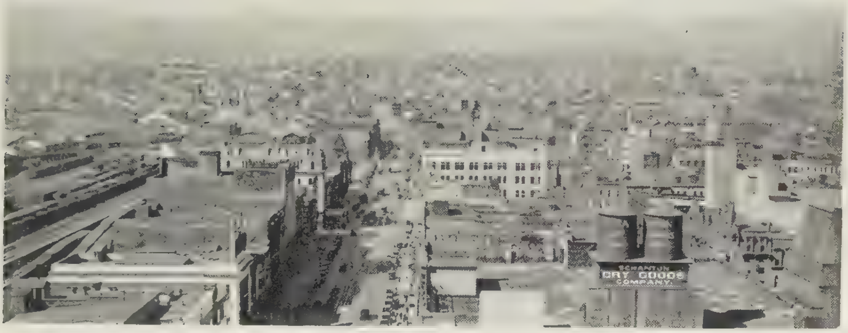

FIG. 3

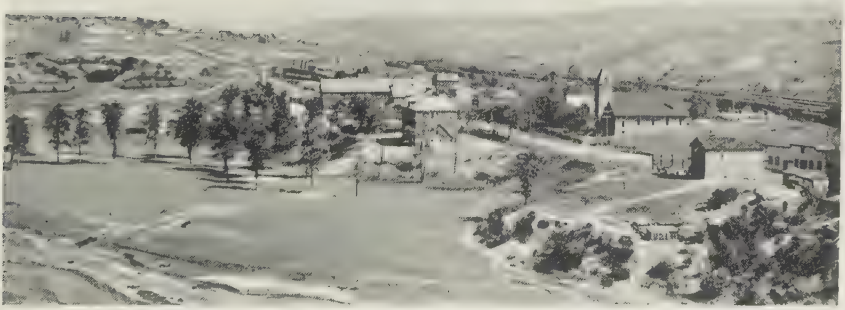

FIG. 4

FIG. 2—Scranton from the mountain ridge at Leggetts Gap looking to the south. The Lackawanna Railroad is shown as it leaves the gap. Across the valley is the ridge of the Moosic Mountains.

FIG. 3—A view to the west from the central business district of Scranton. Note how the city spreads over the low Hyde Park Ridge: Keyser Valley lies beyond, and the tree-covered ridge of the Bald Mountains forms the sky line.

FIG. 4—The south end of Scranton. The Lackawanna Railroad is on the right. Note the spread of the city up the gentle slope of the east mountain ridge, Moosic Mountains. Keyser Creek, choked with mine waste, in the foreground.

collieries and also most of the industrial establishments were located in the lowlands.

The large production of anthracite at Scranton and the strategic position of the city with reference to railroad outlets from the Lackawanna Valley were the primary factors leading to the concentration of railroads at that place. The main line of the Lackawanna Railroad, connecting Hoboken and Buffalo, utilizes both Nay Aug and Leggetts Gaps in crossing the Lackawanna Valley. The Erie Railroad also enters the valley through Nay Aug Gap. Several other railroads approach the city along the axis of the valley. Scranton, because of its importance as a coal-assembling and shipping center and as a freight and passenger division point, was the logical place at which to locate railroad-car and locomotive repair shops. The principal repair shops of the Lackawanna Railroad and the smaller shops of three other railroads are located here. More than 5000 persons are employed in the railroad industries at Scranton.

Scranton is unique industrially not only in that it possesses the combined characteristics of a large coal-mining community and of an important railroad center but also in that it is a significant manufacturing city. About 15,000 persons are employed in its factories. Metal-fabricating plants and textile mills are the two principal types of manufacturing industries. The metal-fabricating plants developed in the city in response to a large demand for machine-shop and foundry products among the local mines and railroads. The textile mills were attracted to Scranton chiefly because many girls and women from among the industrial population were willing to work in the mills for comparatively low wages. Among the textile industries the manufacture of silk is of major importance. A number of the textile mills are situated in residential districts occupied by large numbers of industrial workers. Most of them, however, are situated in the low-lying manufacturing districts of the city. The relative nearness of Scranton to the great centers of silk manufacture on the eastern seaboard also appears to have encouraged the spread of the industry to the coal field.

The central business district is situated on a broad, flat terrace just north of the mouth of Roaring Brook. Several small business districts in other portions of the city were established before the time when those sections were annexed to Scranton. Dunmore's small business center is easily recognized on the map.

The less attractive residential districts occur in the lower portions of the city, and usually they are closely associated with industrial districts. On the other hand, the more attractive home sites are on the minor ridges, where there are relative seclusion from industrial and commercial areas, an abundance of pure air, better drainage, and more pleasing views. Many attractive residences are being built also on the wooded east mountain slope outside the limits of the coal measures.

Along the outer fringes of the city are several small neighborhoods resembling in many respects the typical "mining patches" that have developed around isolated anthracite collieries. They are sharply in contrast with the more developed parts of the city. Most of the residents of each "patch" are employed in the accompanying colliery. In those neighborhoods foreign families predominate, English is seldom heard, unsanitary living conditions prevail, houses are painfully primitive, streets are unpaved, sidewalks are lacking, flocks of ducks and geese and even goats and occasional cows run at liberty through the streets and in the adjoining vacant lots. The huge piles of culm, the sagging and undermined surfaces, the noise of the breakers, the spreading railroad yards, the streams of blackened breaker wash water—all scars of the anthracite industry—combine to destroy the comeliness of the physical environment and to kill the pride of the community.

With the exception of the outlying mining patches, no parts of Scranton are inhabited exclusively by mine workers. Most of the mining population is rather evenly distributed throughout the moderately attractive residential sections of the city, where they are intimately associated with other industrial workers. This distribution of mine workers is related to the fact that the collieries themselves are widely scattered in Scranton. As a result there are fewer predominately mining neighborhoods than there are in many cities of the anthracite region.

Qualities of the City and Its People

Scranton as a city possesses an urban quality that distinguishes it clearly from all other communities in the anthracite region. This may be attributed chiefly to the diversified economic interests of the community, to its large size and compact structure, to its population mixture, and to the ease of communication it enjoys with other urban centers within and without the coal basin.

Quite in contrast with many coal-mining centers, Scranton is a stable and well-rounded community. This also is related to the varied economic interests of the city and to the fact that its principal industry has been carried on steadily for many years because of the large size and the high quality of the local coal deposit. Some 250,000 people live within the metropolitan area of Scranton—ten-mile radius of the city—which fact further suggests the importance of Scranton as a commercial center.

About 20 per cent of the population is foreign-born. The principal sources of this group are Russia, Italy, Ireland, Poland, Austria, Wales, Germany, and England, named approximately in the order of their importance. More than 40 per cent of the population consists of native-born individuals, one or both of whose parents were foreign-born. Most of those citizens originated from northwestern and central European stock. Nearly 40 per cent of the population consists of native white stock of native parentage. As a whole, Scranton presents the racial aspects that are typical of many American industrial communities. In many of the smaller cities of the anthracite region the foreign elements, especially from southern and eastern Europe, are much more numerous. Usually the smaller the mining community, the larger the proportion of foreigners.

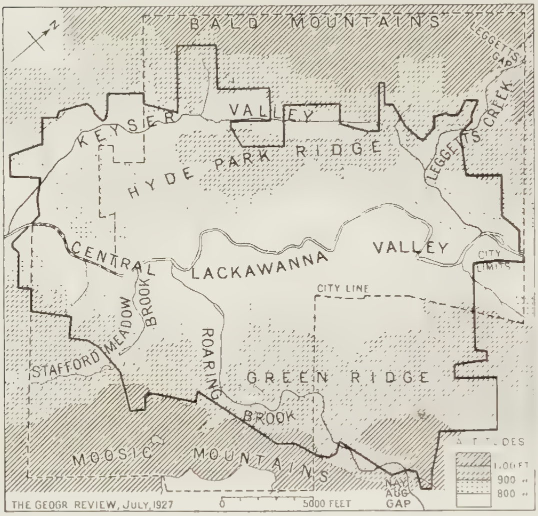

FIG. 5—Topography of the city. Compare Pl. III.

The large demand for laborers of a type already experienced in mining or of a type willing to engage in mining operations has had its influence in attracting certain groups of people to Scranton. The importance of the Welsh population in the city illustrates the acquisition of experienced anthracite miners, while most of the Italian and Polish workers seem to be examples of the other type.

ORIGIN AND GROWTH OF SCRANTON IN RELATION TO ENVIRONMENTAL CONDITIONS

Having interpreted briefly the salient cultural features of the present city, the origin and growth of the community will next be discussed in order to discover, if possible, additional facts that will aid in explaining the qualities of the present city, and the environmental factors which have affected its development.

The area about Scranton was first settled in 1769.[5] Among the first lands to be appropriated were the low, rich bottoms (Capouse Meadow) along the Lackawanna River and within the present limits of Scranton, which apparently had been cultivated even earlier by the Indians. The first colonists came chiefly from Connecticut, entering the Lackawanna Valley along an old Indian trail extending from the Delaware River through Nay Aug Gap to the site of Scranton. By 1788 the number of settlers in the vicinity and the increased production of grain warranted the erection of a gristmill, Scranton's first industrial establishment, on an excellent site offered by the lower course of Roaring Brook. Farmers living 20 miles away sought the mill with their grain. In 1799 the gristmill was improved and enlarged, and a distillery—to use the surplus grain produced in the vicinity—a sawmill, a cooper shop, and a blacksmith shop were erected. A number of houses, together with the group of small industries along the brook, constituted in 1800 the thriving little village of Scranton.

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[5] The chief sources are Horace Hollister: Contributions to the History of the Lackawanna Valley, New York, 1857; *idem:* History of the Lackawanna Valley, 5th edit., 1875; and F. L. Hitchcock: History of Scranton and Its People, 2 vols., New York, 1914.

In that year the first important attempt was made to utilize the mineral resources of the area. A small furnace and a forge were constructed to manufacture plowshares and other farm implements from iron ore exposed along the banks of several creeks in the vicinity. Although coal beds outcropped along the creek banks beside the furnace, charcoal alone was used for fuel.

The expense of manufacturing was so great that only an insistent demand for the products over a wide area made possible the continued operation of the furnace. In 1826 it was abandoned largely on account of difficulties of transportation, attempts to amend which proved abortive for some time. Somewhat later the distillery also was closed, and the village sank into a period of decadence. Hopes of reëstablishing the industry, however, were not lost, and in 1839 the area between Pittston and Scranton was carefully examined for selection of the most practicable location for an ironworks. "On the low, wild, narrow strip of land, lying almost in the forks of the Lackawanna and the Roaring Brook," iron ore was found, "the analysis of which proved so productive and inviting as to determine at once the site of the furnace."[6] Anthracite was to be used for fuel in the new furnace instead of charcoal. High-grade coal outcropped in a ten-foot vein on both sides of the creek and within a few rods of the furnace. The adjacent ore deposit proved to be too expensive to work, but fortunately "a rich body of iron ore" was discovered on the slope of the Moosic Mountains, about three and a half miles from the furnace. For several years after its completion in 1841, the operations of the furnace were successful metallurgically, although the quantity of iron made was less than had been expected.

At that time the principal market for the product of the furnace was on the eastern seaboard. In order to reach that market the company had the choice of two routes, both of which were hard, slow, and expensive: the one along the Delaware and Hudson Canal to Rondout on the Hudson, the other along the North Branch Canal,

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[6] Hollister, Contributions, etc., pp. 106–107.

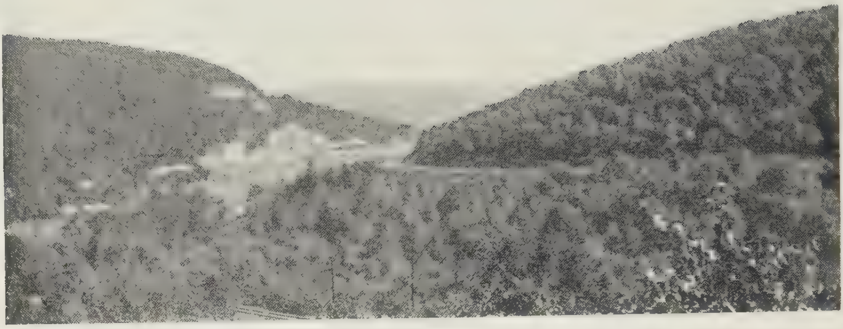

FIG. 6

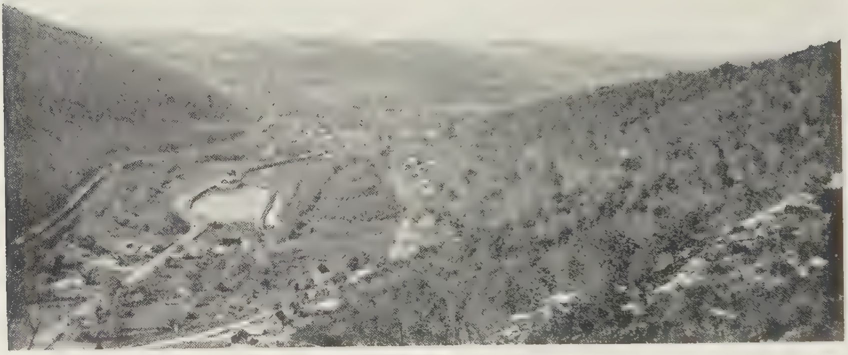

FIG. 7

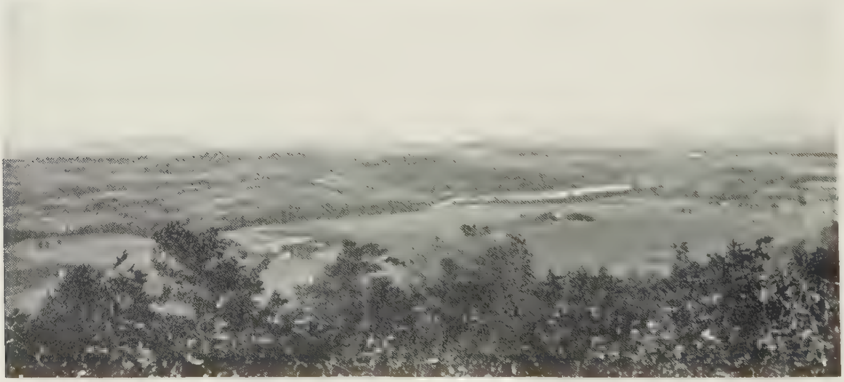

FIG. 8

FIG. 6—Nay Aug Gap cut by Roaring Brook in the ridge of the Moosic Mountains to the east of Scranton. The Lackawanna Railroad on the left, the Erie Railroad on the right.

FIG. 7—Leggetts Gap through the ridge of the Bald Mountains to the west of Scranton. The Lackawanna Railroad on the farther side of the gap. In the center the Lackawanna Trail and the Northern Electric Railroad, both of which extend to Binghamton, N. Y.

FIG. 8—The mixed farming and dairying region which lies to the northwest of Scranton as seen from the top of the forested ridge of the Bald Mountains near Leggetts Gap.

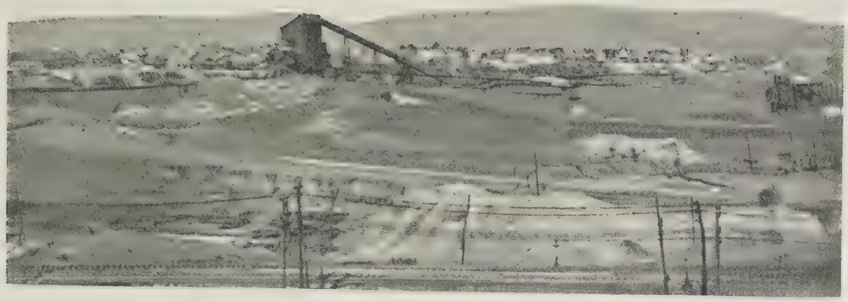

FIG. 9

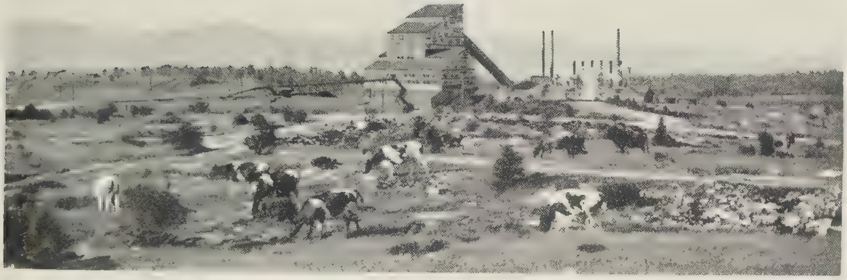

FIG. 10

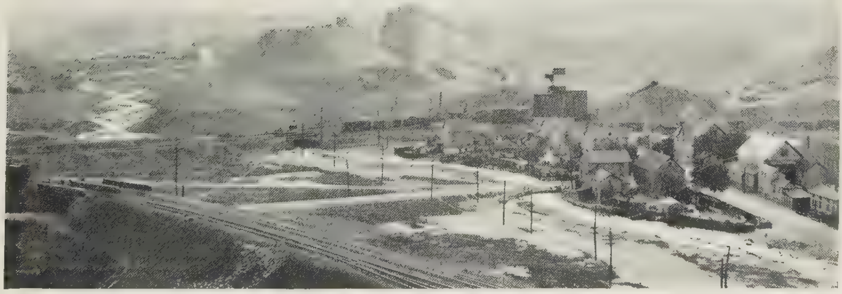

FIG. 11

FIG. 9—A breaker near the central part of the city. Many acres of valuable city land are covered with heaps of blackened mine waste and fine coal.

FIG. 10—A large modern breaker in the Dunmore section. The surrounding land is fractured and caved as a result of mining operations. Caving is a serious municipal and industrial problem.

FIG. 11—A small "mining patch" on the south side of Scranton. Note the silt-laden stream of breaker wash water, the huge piles of mine waste, the silt-covered areas along the stream, and the crowded, unattractive settlement.

which extended along the Susquehanna River to Havre de Grace, Maryland. In both cases the iron had first to be hauled considerable distances by wagon. To the North Branch Canal at Pittston the distance was seven miles. To Carbondale, the terminus of the gravity railroad extending over the mountains to the western end of the Delaware and Hudson Canal at Honesdale, it was 15 miles.

The enterprise thus far had been a losing one, and when it became apparent that to continue selling pig iron alone would always be unprofitable a rolling mill and nail factory were added. This marked the turning point. In 1846 an order for 12,000 tons of iron rails was secured from the Erie Railroad—an order of great significance to the Scranton company.

Scranton at that time began its rapid development. Two large blast furnaces were erected. A well-graded railroad, using mules for drawing the cars, was constructed to the ore deposit. On the south side of Roaring Brook some 300 houses for the workmen were built. As the production of the blast furnaces was not equal to the needs and capacity of the rail mill, pig iron in large quantities was purchased in Columbia County and brought by canal to Pittston and then by wagon to Scranton. Limestone also was brought from near Danville along the same route.

The rapid expansion and concentration of business at Scranton soon emphasized the necessity of having some satisfactory connections with the Atlantic seaboard and also with the Great Lakes. The owners of the ironworks frequently discussed the importance of a railroad leading to the market as a necessary adjunct to their business. In fact it was the most confident expectation of a railroad being extended both to the east and west at no distant date that went far toward the selection of Scranton as the site for their industry. The charter of a partially surveyed railroad extending northwest from Scranton through Leggetts Gap and joining the Erie Railroad at Great Bend was purchased, and the road, 48 miles in length, was completed in 1851. To carry out the original plan of connection with New York City, a survey was made in 1851–1852 for the railroad to the east through Nay Aug Gap. Early in 1856 it was completed to the Delaware River where it joined the Central Railroad of New Jersey, the two forming the first all-rail connection between the anthracite fields and New York City. At that time the two roads extending to the east and to the west of Scranton were consolidated under the name of the Delaware, Lackawanna, and Western Railroad. Thus after a struggle extending over several decades, Scranton finally was made accessible by railroad to both eastern and western markets, a triumph largely due to the city's position between two favorably situated gaps in the bordering mountain ridges. The two greatest factors in the fortunes of Scranton at that time were the Lackawanna

Iron and Coal Company and the Delaware, Lackawanna, and Western Railroad. So greatly were the interests of the town, both individual and corporate, identified with those two corporations that everything revolved about them. The two corporations owned most of the land within the city, and the prices of land fixed by the Lackawanna Iron and Coal Company were a standard.

After the completion of the east and west railroads the production and shipping of coal, which proved to be the underlying basis for most of Scranton's later growth, was begun. For some time, however, much difficulty was experienced in marketing large quantities of the product at a profit, for most coal consumers were unaccustomed to anthracite.[7] The owners of the ironworks, nevertheless, opened several collieries to tap the rich reserves of coal, and for years they were the principal shippers of anthracite from Scranton.

The extension of the lines of the original Lackawanna Railroad and the invasion of the city by new railroads in order to acquire a share of the profitable coal traffic further aided the development of Scranton. The Lackawanna acquired branch roads extending through the coal field both to the north and to the south, and thus it early became one of the principal anthracite-carrying railroads. When the coal properties of the Delaware and Hudson Company in Scranton were developed in 1860, their railroad was extended to the city. A branch of the Erie Railroad was constructed by way of Nay Aug Gap and the Valley of Lackawaxen Creek to serve the collieries of the Pennsylvania Coal Company at Dunmore and elsewhere. In 1886 and in 1890 branches of the Central of New Jersey and the New York, Ontario, and Western railroads, respectively, were extended to Scranton to tap that portion of the coal field. Thus it is seen that as large, new companies acquired collieries in the Scranton district each planned a new transportation line because of the close relationship existing between coal mining and transportation interests. With the invasion of the city by numerous railroads, Scranton's importance as a coal-shipping center increased, and the city also benefited through the establishment there of repair shops and other railroad industries.

Along with the expansion of the coal-mining and railroad industries, there developed in Scranton a group of metal-fabricating industries whose products were in demand among the railroads and the collieries. The textile industries began to appear shortly before 1880 and rapidly increased in importance. Both of these groups of industries have had an important part in the growth of the city.

The annexation of Hyde Park and Providence boroughs to Scranton in 1866 is another fact that helps to account for the growth of the city. At that time Hyde Park was a thriving little community, and since it contained several producing collieries its annexation was of immediate importance. Only the river separated it from the Scranton of early days. Providence was a small village separated from the other boroughs by a mile and a half of vacant land and lying along the most direct route of travel between Leggetts Gap and the main highways of the Lackawanna Valley.

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[7] Hitchcock, *op. cit.*, p. 62.

Dunmore was an isolated village at the foot of one of the gravity planes operated over the Moosic Mountains by the Pennsylvania Coal Company for transporting coal from the Lackawanna Valley to the Delaware and Hudson Canal at Hawley. Later coal mining was begun in Dunmore, and from that time the collieries of the Pennsylvania Coal Company have been the principal cause for the growth of the place. The formation of the new county of Lackawanna from the northern portion of Luzerne County, in 1878, and the selection of Scranton as the county seat undoubtedly contributed to the growth of the city.

In 1901 Scranton lost an industry which for 60 years had been of great significance in the development of the city. In that year the iron and steel furnaces and rolling mills of the Lackawanna Iron and Coal Company were abandoned and the plant was reëstablished at Buffalo. Furnaces at Buffalo were far better situated for utilizing Lake Superior ore, good coking coal could be secured cheaply, and Buffalo was no less favorably situated than Scranton with regard to important markets for iron and steel products. When coke was widely substituted for anthracite for fuel in blast furnaces (about 1875), Scranton lost one of the principal attractions it originally had to offer the industry. The low-grade iron ore deposits at Scranton were entirely inadequate to supply the needs of the industry as soon as it attained a large size. Most of the ore used by the furnaces at Scranton in later years was secured from Danville and Bloomsburg, Pennsylvania, at considerable cost.

In spite of that enormous industrial loss at the opening of the twentieth century Scranton surmounted the difficulty, as is shown by its continuous growth in population. Expansions of the coal and railroad industries were the principal factors that prevented an appreciable slump in the development of the city at that time. The larger non-mining industries of present-day Scranton have become so firmly established that they probably will continue to prosper long after mining has ceased to be significant. Furthermore, because of Scranton's regional position and its excellent transportation facilities, other industries may be introduced which will further help to insure the future of the community.

A PICTURE OF THE DISTRIBUTION OF POPULATION IN PENNSYLVANIA

Clarence E. Batschelet

U. S. Bureau of the Census

THE accompanying map, Figure 1, portrays the distribution of population in Pennsylvania by the "dot" method.[1] Irregular symbols are used for the larger cities, those having 50,000 population or more.[2] The census of 1920 returned 13 places with such a population, the largest, Philadelphia, having 1,823,779 inhabitants. The cities and boroughs having a population of under 50,000 were divided into three groups, and the area of the circles was apportioned to the total population as represented by these groups: places of from 25,000 to 50,000 population, of which there were 7; 10,000 to 25,000 population, of which there were 57; and 2500 to 10,000 population, of which there were 237. For the remaining population of the state, i. e. the population of incorporated places under 2500 and the unincorporated segregated population, as well as the rural population, a unit of 200 population was used, with the size of the dot in proportion to the circles used for the larger cities.

Size and Location of Dots

The question as to the size of the dot and the number of persons represented was perhaps the most difficult problem presented by the map, and it was only after considerable experimental work, in which dots representing from 50 to 500 persons were plotted in the most sparsely as well as the most densely settled townships, that it was decided to use a dot to represent 200 persons. A dot representing less than 200 covered the space and made too dense a mass, thereby destroying the detail; and if the unit represented more it necessitated too great centralization of the dots for the scattered population, thereby distorting the picture.

In locating the population the dots were placed geographically for the incorporated boroughs and cities. For the unincorporated places and the rural population the United States Geological Survey topographic sheets were used. Sheets were available for approximately two-thirds of the state, or 30,000 square miles out of a total of 44,832.

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[1] Compare Wesley Coulter: A Dot Map of the Distribution of Population in Japan, *Geogr. Rev.*, Vol. 16, 1926, pp. 283–284.

[2] Data from Fourteenth Census, Vol. 1: Population—Number and Distribution of Inhabitants and unpublished statistics for Census Enumeration Districts.

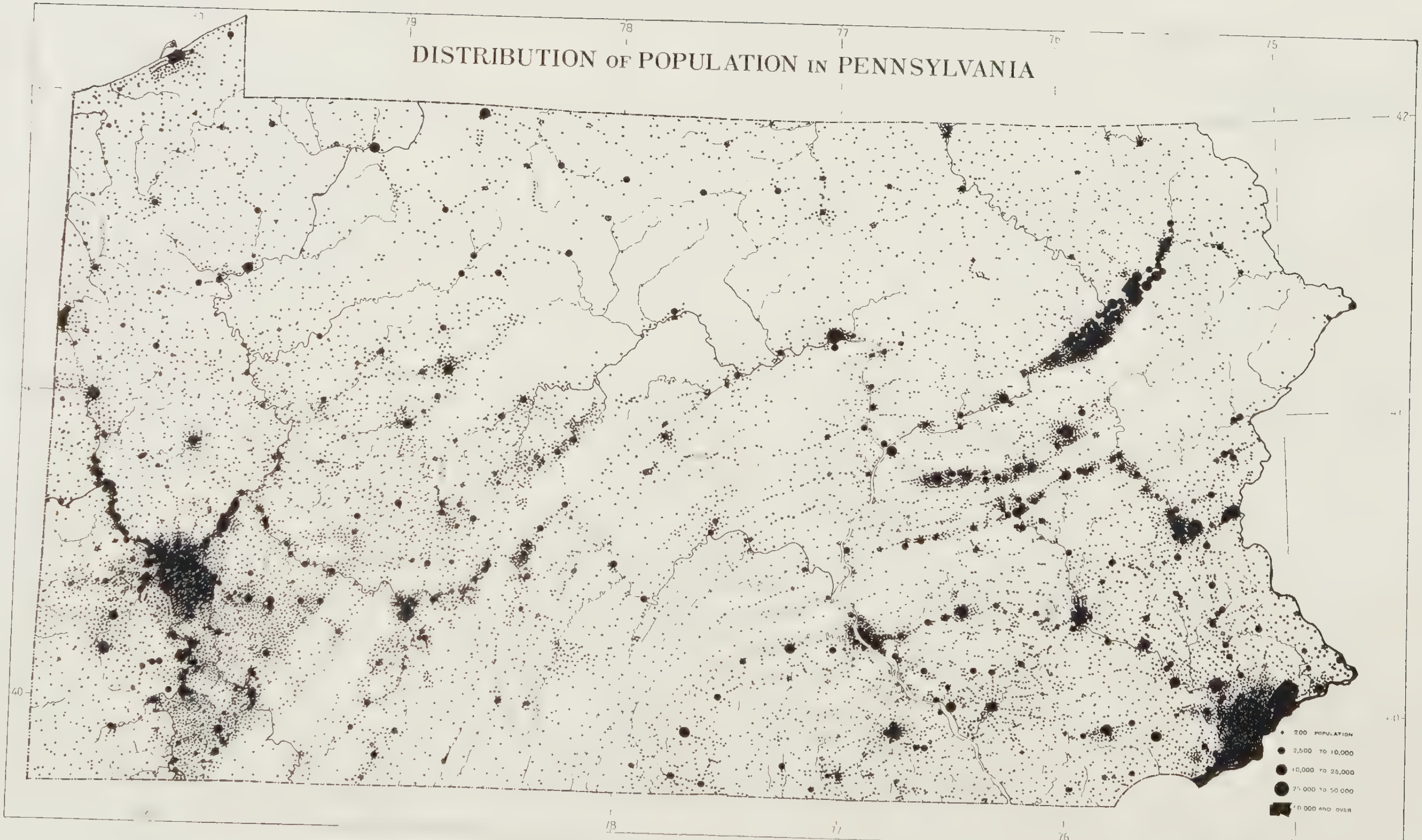
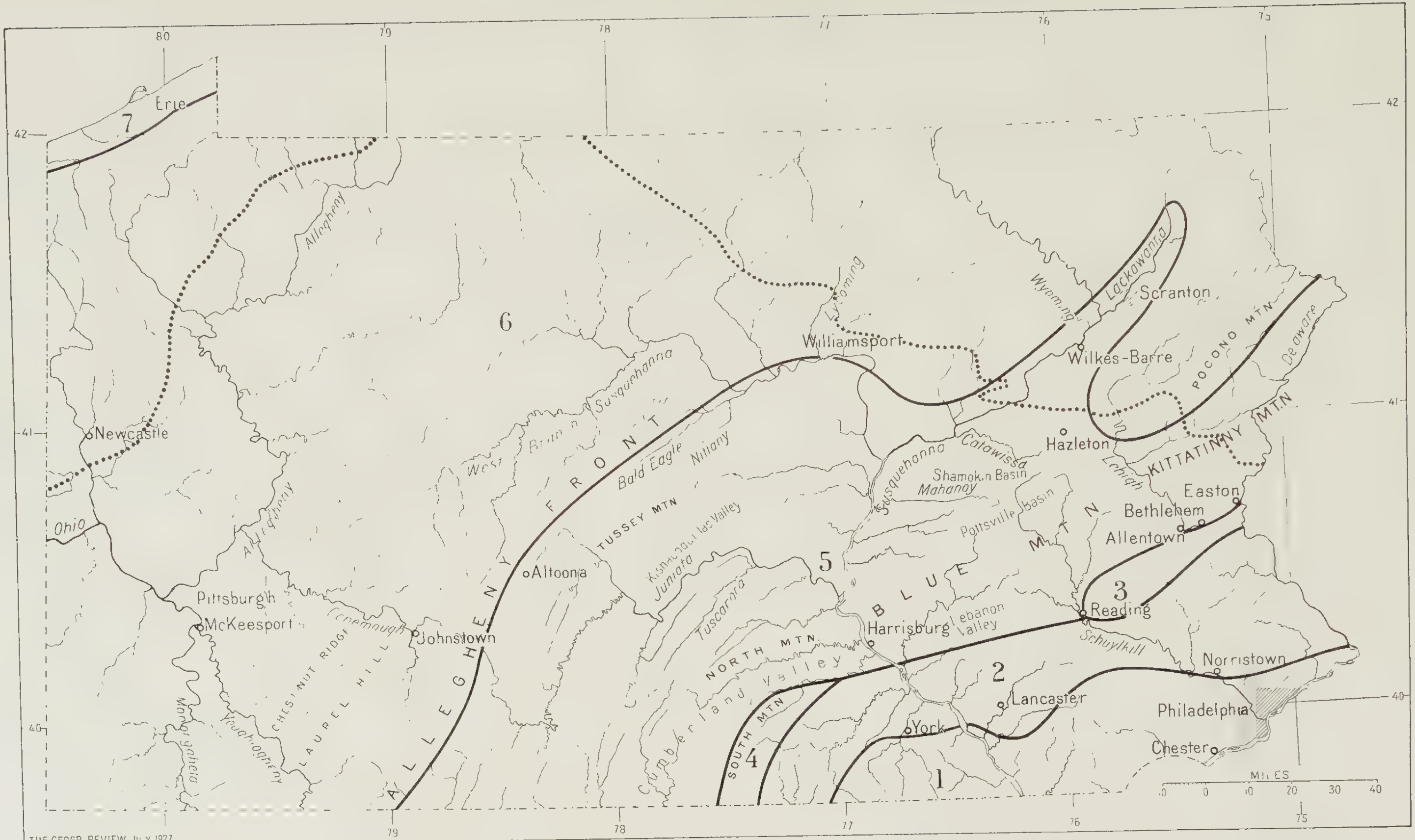


FIG. 1—Distribution of population in Pennsylvania. Scale approximately 1 : 2,800,000.



THE GEOGR REVIEW, JULY, 1927

FIG. 2- Map of Pennsylvania showing the physiographic provinces, the cities of over 25,000 population, and some important feature names. The numbers refer to the physiographic provinces: 1, Piedmont Upland; 2, Piedmont Triassic Lowland; 3, Blue Ridge; 4, New England Upland; 5, Appalachian Valley; 6, Appalachian Plateau; 7, Central Lowland of the Interior Plains. The glaciated regions of the northeast and northwest are delimited by a dotted line.

Had the state been completely surveyed the entire study could have been greatly facilitated. For the territory not surveyed in detail, the State Highway map, scale six miles to the inch, issued by the State Highway Commission, showing roads and towns as well as county and township boundaries; the Electric and Steam Railroad map, scale six miles to the inch, issued by the Public Service Commission; and other standard maps were used.

A county map showing township lines, with the dots as finally plotted thereon, was sent to each county agricultural agent with the request that he examine critically the location of the dots as representing the actual distribution of the rural population. The replies received from these agents were gratifying in that for most of the counties the distribution was stated to be satisfactory.[3] Verification was particularly desirable where topographic sheets were not available and for some sections of the state where the population had changed materially since the survey had been made.

Relation to Topography

The population density is closely related to the relief. It is noticeable how thickly the population is located in the rich farming valleys and how in the central part of the state, the Appalachian Valley, these parallel the mountain ridges. This is in striking contrast to the scattered population in the northern central part of the state. One can easily follow the direction and location of the Chester, Lancaster, Lebanon, Cumberland and York, Schuylkill, Lehigh, Nittany, and Kishacoquillas Valleys, for instance. The population map, Figure 1, should be compared with Figure 2 showing the boundaries of the physiographic provinces[4] and for detail should be compared with the geological map or the soil maps of the state.[5]

The districts immediately surrounding Philadelphia, Pittsburgh, and Scranton are densely populated. The Middle and Southern Anthracite Basins, with Hazleton, Shamokin, and Pottsville as their chief centers, also stand out distinctly. Another interesting feature is the alignment of the population along roads and electric lines radiating from cities, such as York, Lancaster, Harrisburg, and Johnstown.

In contrast we note the lack of people living on the Pocono, South, Blue, North, Tuscarora, and Tussey Mountains, the Chestnut Ridge, and the Alleghany Front. The direction of the mountain folding is clearly depicted by the population distribution.

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[3] For 18 of the 67 counties minor changes were suggested; for 7 counties no replies were received; and for 2 counties there were no letters sent, as the counties had no county agents.

[4] Compare A. K. Lobeck: The Physiographic Influence Upon the Distribution of Population in Maryland and Pennsylvania, *Annals Assn. Amer. Geogrs.*, Vol. 16, 1926, pp. 94–101.

[5] Reconnaissance Survey Soil Map of Pennsylvania: Southwestern sheet, 1909; northwestern sheet, 1909; south-central sheet, 1910; northeastern sheet, 1911; southeastern sheet, 1912. U. S. Bureau of Soils.

In the Piedmont Upland area the density is nearly 1200 per square mile, compared to a density in the glaciated area of the Appalachian Plateau of about 50 per square mile. This latter area is rough and has little good tillable land except between the ridges and on their lower slopes. There is, however, an appreciable difference in pattern of population distribution between the glaciated region and the contiguous part of the Appalachian Plateau, the former showing more even distribution, the latter being notably confined to the valleys. This unglaciated plateau country beyond the northern end of the bituminous coal field is the most scantily populated part of the state. Topography is very rough: a considerable area is properly preserved in state forests.[6]

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[6] See State Forest Map of Pennsylvania on the scale of six miles to an inch, Dept. of Forestry, 1922.

SOME ECONOMIC PROBLEMS IN THE BALTIC REPUBLICS

A REVIEW OF RECENT LITERATURE

Eugene Van Cleef

Ohio State University

ONE of the important consequences of the Great War was the sloughing off from Russia's western periphery of four new republics: Finland, Estonia, Latvia, and Lithuania. As separate political entities they found themselves confronted with serious problems: only Finland, which had possessed a qualified domestic autonomy, had experience to build on. To quote from a recent survey: "It is impossible to compare pre-war and post-war Latvia from an economic point of view, as before the war Latvia was nothing more than a factor in the Russian industrial system, pursuing entirely different aims from her present-day objects."[1] That these patient groups of the north have succeeded well in spite of their disabilities is revealed in the rather meager literature describing their recent activities.

In all four states the agrarian problem repeatedly comes to the fore. The industrial phases of the struggle receive nearly as much attention, since a goodly portion of the political development not only has brought the agrarian and industrial views into sharp contrast but oftentimes almost to the point of destructive conflict. The clash of ideas has arisen largely out of the paucity in variety of natural resources, the preponderance of those whose greatest value is attained through industrial manipulation, and the geographic conditions peculiar to the respective countries. Although the problems confronting each of the new republics are fundamentally similar, their variations are sufficiently diverse to warrant consideration by individual countries.

Finland

A region lacking the possibility of producing sufficient food for itself can hope for progress only if it possesses a surplus of some readily marketable resource. For Finland the forest plays a saving rôle.

"The greatest economic wealth of the country is contained in the forests of Finland," says Numelin[2] in a discussion of the economic

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[1] *Econ. Rev.*, Vol. 14, London, 1926, Aug. 13, p. 148. This is equally true of Estonia and Lithuania. In addition it must be recalled that these regions were thoroughly disorganized as a result of the war.

[2] Ragnar Numelin: Some Aspects of the Geography of Finland. Government Printing Office, Helsingfors, 1923.

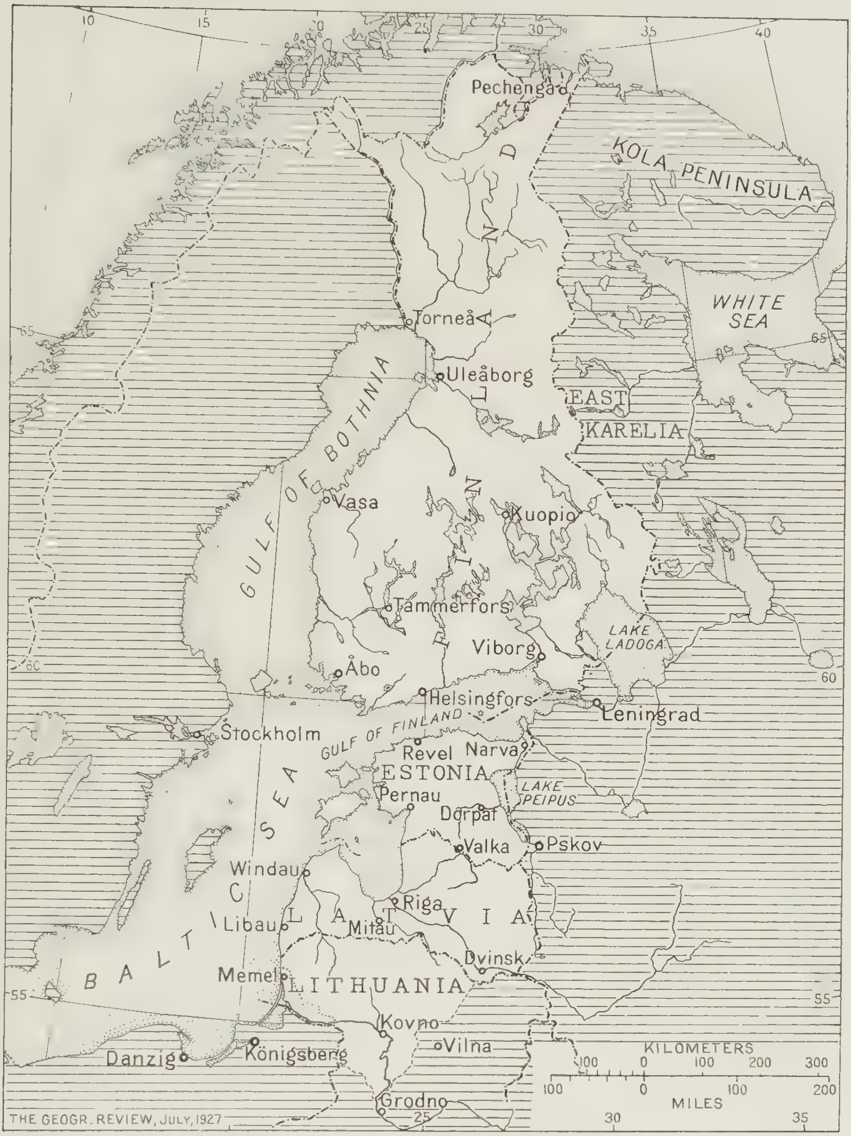

FIG. 1—Map of the Baltic States of Finland, Estonia, Latvia, and Lithuania. Scale 1 : 13,000,000.

activities of Finland in one of his recent brochures. The widespread distribution of the thousands of lakes combined with their navigability as well as their proximity to one another has contributed to the spreading of the population over the country and has facilitated commerce. But more important than the waterways are the forests, which represent the primary economic wealth of the country. Ilvessalo[3] points out that over 73 per cent of Finland's area is in forest, while over 58 per cent is productive forest land. Of the forested area 55 per cent consists of pine (*Pinus silvestris*), with spruce (*Picea excelsa*) and birch (*Betula odorata and Betula verrucosa*) constituting most of the remainder. These types are well adapted for timber production. Although over half is privately owned, regulation of cutting and planting has been so effective that at present "the amount of the annual increment is 44.40 million cubic meters while consumption is estimated at 40 million cubic meters."

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[3] Yrjo Ilvessalo: The Forest Resources of Finland. Helsingfors, 1924. Reprinted from Communicationes Ex Instituto Quaestionum Forestalium Finlandiae Editae 9.

The timber industry and its influence upon the whole economic structure of the country are clearly presented by Kovero,[4] Director of the Central Statistical Bureau, through the medium of numerous tables and their lucid interpretation. "The wood trade," says Kovero, "may be considered as the most important branch of Finnish industry." Its significance lies not only in its money value but in the full-time employment which it offers the people, "about one-third of all the factory workers in the country [being] employed in the wood industry," and in the part-time employment afforded farmers whose crop income during the long winter season is negligible and for whom life on the farm would be impossible if, in many instances, it were not for the supplementary income provided by the industry.

The Agrarian Problem

The timber resources have a close relation to industrial development. Agricultural interests are to some extent opposed. The two elements have given birth to two strong political parties. The agrarian element has grown in strength rapidly. At the end of the first six years of the republic, Dr. Relander, of the Peasants' League, was elected to the presidency, and 22 per cent of the parliamentary representation belongs to that party.[5]

The official statement "Land Reform in Finland, 1922" gives a summary of the earlier stages of the movement.[6] From the beginning of the century endeavors had been made to provide land for the landless but with no great success while the country remained dependent. After 1917 reform began in earnest and, thanks to the legislation of 1918, "by the end of 1922, no less than 50,000 small holdings, crofters and rural dwelling sites, have been reconstituted as independent freehold properties." In 1922 a law "for the provision of land for the purpose of colonization" went into effect. Reviewing this law the

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[4] Martti Kovero: The Timber Industry of Finland. Government Printing Office, Helsingfors, 1924.

[5] For a summary of political parties and the relative position of the agrarian element in this and the other Baltic States see the Council on Foreign Relations' publication edited by Malcolm W. Davis, "A Political Handbook of Europe," New York, 1927.

[6] Land Reform in Finland, 1922: Official Statement. Government Printing Office, Helsingfors, 1923.

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of agricultural products. Frosterus' soil classification should prove an invaluable aid to a scientific development of Finland's agriculture. Although interpreting it in the light of Finnish enthusiasm for soil cultivation, one cannot help feeling that the agricultural future as pictured by the Finns is fraught with serious difficulties.

The record of a typical year (1924), analyzed by the Department of Overseas Trade of England,[9] reveals that over one-third of Finland's imports consisted of foodstuffs and that less than one-sixth of her total exports were agricultural products, while her timber products and their derivatives made up 86 per cent of the total exports. In this same year over one-third of the imports were foodstuffs, paid for largely from the proceeds of forest-products sales. After discussing the crop difficulties the report proceeds to the following conclusion: "The farmer is now . . . beginning to turn his attention to cattle-breeding and Finland, in this respect, appears to be gradually returning to the conditions prevailing before the Great War. . . . The transfer from agriculture to cattle-breeding has been of late so prominent a feature that the Government has been obliged to consider means of improving the cultivation of grain."

A graphic presentation of Finland's agriculture appears in an atlas printed with Finnish, Swedish, and French text, the French title reading "L'Agriculture de la Finlande en Diagrammes et Cartes."[10] This scholarly atlas, including a reproduction of maps and diagrams prepared for the Twelfth Finnish Agricultural Exposition, has received official recognition and assistance. It brings down to 1920, and in some instances to 1922, data that were first presented in the "Atlas de Finlande" of 1910. A detailed review of the 317 maps and diagrams cannot be presented here, but for the student of Finland's agriculture this atlas is indispensable. One is impressed by the country's agricultural progress as well as that of her forestry, for which data are included in the atlas. While forestry is not commonly classified as agriculture, there appears no serious objection to construing it so in the case of Finland, where the forests are under control and are planted and cropped annually. In addition to the graphical representation of crop areas and production, the subject of coöperative societies concerned with production, with export, with farm financing, and virtually every activity in any way directly associated with or growing out of agriculture receives detailed consideration.

Water Power

Although the annual forest increment exceeds consumption by about four millions of cubic meters, any economy which can be effected in domestic consumption will release that much more for export. The prospect for further saving is revealed in the water-power development both under way and potential. Christiernin reports the potential power in Finland as totaling 2,500,000 horse power.[11] Developments now under way will provide sufficient power not only for the local sawmills and paper mills but for operating the main-line railroads in southern Finland, which in the absence of domestic coal burn considerable quantities of wood as locomotive fuel. This new power will also serve the farms. Christiernin states that "five years ago only twenty communes in Finland were supplied with electric energy, whereas this year [1923–1924] the number partly or wholly electrified amounts to 200, or 40 per cent of the total number."

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[9] C. H. Mackie: Rept. on the Economic, Financial, and Industrial Conditions of Finland. Department of Overseas Trade, H. M. Stationery Office, London, 1925.

[10] Suomen Maataloutta Kuvioin ja Kartoin. Edited by K. J. Ellilä, E. Cajander, E. Hynninen, O. Heikinheimo, J. Jyske, and Simo Lilja. Werner Soderstrom Osakeyhtio, Porvoo, 1925.

The Karelian Boundary Question

An international political controversy involving the territory of East Karelia[12] in Russia apparently has found at least a part of its stimulus in Finland's desire to increase her forest resources. When Finland signed the treaty of peace with Soviet Russia at Dorpat, 1920, the question of the autonomy of East Karelia arose.[13] The Soviet[14] régime agreed to East Karelian domestic autonomy, while Finland was desirous of Karelian self-determination in the hope that the Karelians would express the wish to join their brothers in western Karelia already incorporated within Finland. The wish was expressed, but the Soviets ignored it and also refused to permit the League of Nations or any other proposed intermediaries to interfere in the matter. The documents presenting the exchange of notes between Finland and Soviet Russia and the opinions of influential Finnish leaders might lead one to suspect that while the Finns were sincere in their desire to see all Karelians freed from Russia and brought within the political boundaries of Finland, they undoubtedly saw an economic advantage to themselves in the resources of East Karelia.

In a valuable work entitled "Nordeuropa" Gustav Braun[15] discusses the relation between East Karelia and Finland. He sets up his own conception of "Nordeuropa," drawing upon geological and geographical data to justify it. In addition to the Scandinavian Peninsula, Finland, and the Kola Peninsula, he incorporates within the region that territory now included within East Karelia and a trifle more; and he claims for the entire area essential geographic unity. Braun also considers the Kola Peninsula as pertaining geographically to Finland.

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[11] Georg Christiernin: Finland's Water-Power and Electrification. Government Printing Office, Helsingfors, 1924.

[12] "East Carelia and Kola Lapmark," edited by Theodor Homén, published in 1921, gives an excellent account of the geography of the region.

[13] La Question de la Carélie Orientale (Septembre 1924). Government Printing Office, Helsingfors, 1924.

[14] Avis des jurisconsultes étrangers sur la question de la Carélie Orientale (1922–1923). Délégation Carélienne, Helsingfors, 1923.

[15] Gustav Braun: Nordeuropa. (Enzyklopädie der Erdkunde.) Franz Deuticke, Leipzig and Vienna, 1926.

Estonia and Latvia

In the new Baltic States to the south of Finland problems analogous to, but in many respects more difficult than, those of the far northern republic are in process of solution.

THE AGRARIAN QUESTION

In an excellent portrayal of the complexity of the Estonian-Latvian problems, largely agrarian in character, Ifor L. Evans[16] refers to the "agrarian drama" as a "story of bitterness and brutality not unfitted to the cold and somewhat monotonous landscape, the rather barren soil, and the rigorous climate of these uninviting Baltic lowlands." The struggle has been intensified somewhat by the ravages of the Great War, the subsequent Russian Revolution, and the desires of the political theorists to put into effect their utopian ideas. The successful resistance against the onslaughts of all these discouraging incursions inspires confidence for the future development of these countries.

Evans points to the long struggle of the peasantry, going back to the early thirteenth century when "the Church and the Teutonic Order between them . . . became the feudal lords of almost the whole of the country . . . the lack of support from Germany, and the cost of defence, led, from the very beginning, to the exaction of tithe and tribute from the native inhabitants." As a consequence of the Russo-Swedish struggles for territorial ownership and the struggle between Poland and Russia, Sweden acquired Estonia and northern Livonia in the middle of the sixteenth century, while Poland annexed the rest of Livonia. In the process "the land had been laid waste to such an extent that 'between Dorpat, Riga and Pernau neither the bark of dog nor the crowing of cock was to be heard.' " This story of distress has been repeated again and again, down to and including the last internal revolutions in the years 1917 to 1921. While at the time of these last revolutions the peasantry owned between 57 per cent and 64 per cent of the agricultural land, there still remained large numbers of "landless proletariat" who wanted land. The very prosperity of the peasant proprietors made the still existing remnants of the feudal régime increasingly irksome to them. Accompanying this desire for landownership there developed a consciousness which today expresses itself in an almost "rabid" spirit of nationalism.

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[16] I. L. Evans: The Agrarian Revolution in the New Baltic States, I: Estonia and Latvia, *Slavonic Rev.*, Vol. 3, 1925, pp. 587–608.

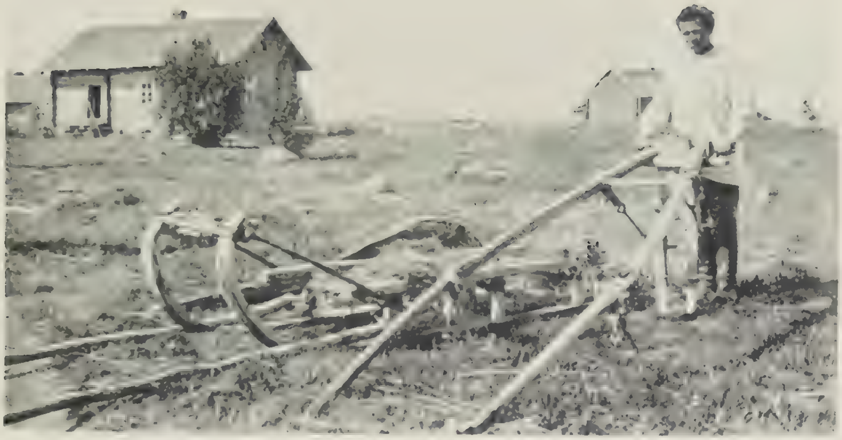

FIG. 3

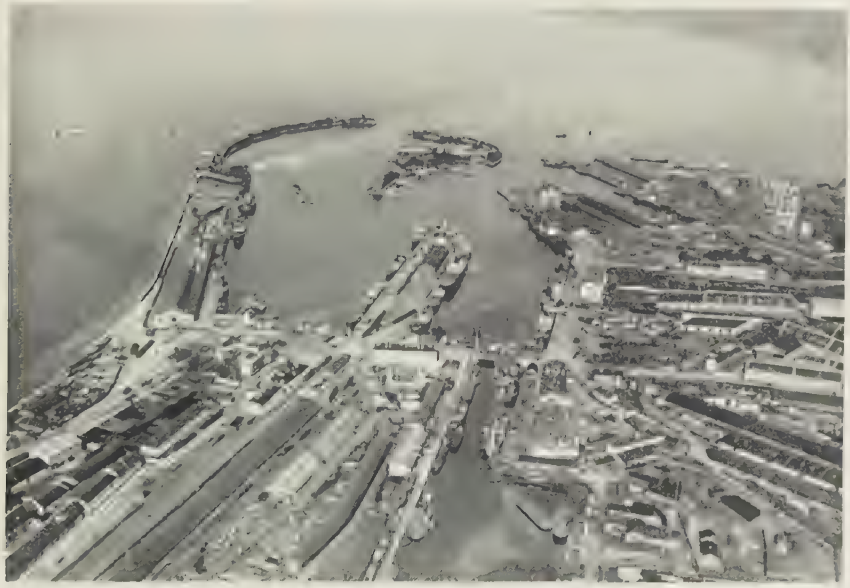

FIG. 4

FIG. 3—Primitive homemade plow and hay sled still commonly used on the remote farms of western Karelia. Note the glacial boulders in the background.

FIG. 4—The splendid port of Tallinn (Revel) commands the trade of Estonia and a fair portion of that of Soviet Russia. Russia enjoys all the port privileges except the right to utilize the port in any way as a military base.

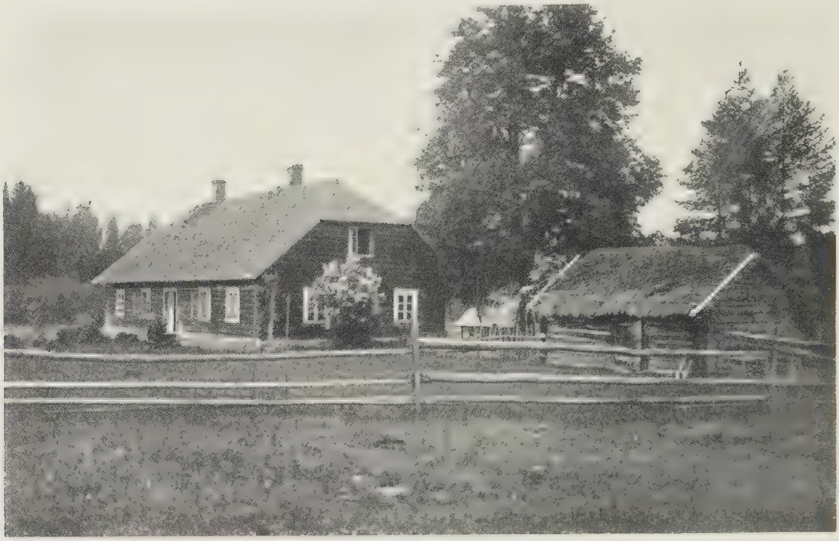

FIG. 5—Home of a prosperous Latvian farmer. Compare the new-style house in Figure 7. (Photograph by courtesy of Latvian Foreign Press Bureau.)

LAND DISTRIBUTION IN ESTONIA

That the agrarian revolution is not at all new is the argument of G. E. Luiga,[17] who presents an illuminating review of the agricultural situation in Estonia. The old order had been protested for years, but only with the establishment of Estonian independence was it possible to inaugurate agricultural reform laws with respect to landownership in a manner satisfactory to the peasantry. The Constituent Assembly of April 23, 1919, passed a new agrarian law which restricted the sizes of the estates and thereby automatically released much land for distribution among the masses. In the appendix to Luiga's booklet, Warep presents a detailed, thorough, concise statistical statement relative to the distribution of the land before and after the new land law became effective. A total of 2,346,494 hectares—not far short of six million acres—were withdrawn from farmer, private, state, and church ownership and distributed among the landless.

A reaction set in after the distribution. Many of those who believed that title to farm property would automatically enrich them or at least remove them from the border line of starvation, became disillusioned, discovering that *work* was an essential requisite to production. Their disappointment nearly created another revolution, but timely action by intelligent leaders forestalled such a catastrophe. With financial assistance from the government and schooling in modern agricultural methods, the peasants, as well as urban peoples

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[17] G. E. Luiga: Die Neue Agrarverfassung in Eesti. With Appendix: A. Warep: Die Neue Landordnung. Dorpat, 1924.

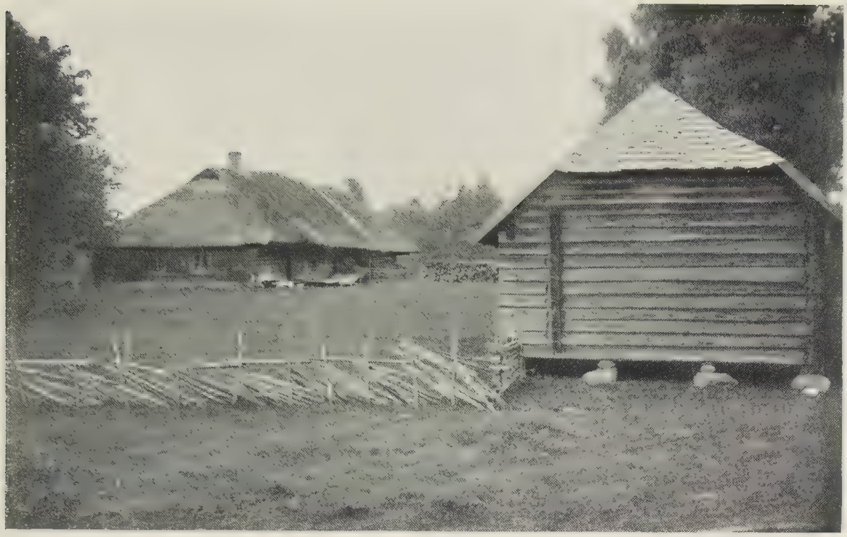

FIG. 6—A less up-to-date farmhouse in Latvia. (Photograph by courtesy of Latvian Foreign Press Bureau.)

who acquired farmsteads, found a way out, and now after five years of experience under the new régime the future seems to offer real hope. Haltenberger,[18] in the chair of geography at the University of Dorpat, describes the country as fundamentally agricultural and as having no prospect of a major development in other directions. He likens the country to Holland, a region of intensive agriculture including dairying, and contends that Estonia may, if it chooses, evolve likewise. Convinced that the future of the country must trend in this direction, he emphasizes the physical aspects[19] a knowledge of which he considers basic for a systematic agricultural program.

THE PROBLEM IN LATVIA

Latvia's problems do not differ materially from those of Estonia. The struggles for landownership in the two countries have paralleled each other, and recent developments in the two regions have attained virtually the same status. Perhaps the best brief account in English of what has taken place in Latvia is given by Owen Rutter in his commendable book on "The New Baltic States."[20] Despite its

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[18] Michael Haltenberger: Landeskunde von Eesti, I: Die physische Struktur des Landes. Tartu (Dorpat), 1926. See also his paper "Der wirtschaftsgeographische Charakter der Städte der Republik Eesti," Tartu, 1925.

[19] Other geographical studies have already been produced by the Geographical Institute of the University of Dorpat, and this institution is in touch with a society for the study of the country founded in 1920. In 1925 the Society produced a monograph of over 700 pages on the department of Tartu, reviewed elsewhere in this *Review*. A good summary account of Estonia is given by Jonatan Grufman: Estniska republikens geografi, *Ymer*, Vol. 43, 1923, pp. 452–491.

[20] Owen Rutter: The New Baltic States and Their Future: An Account of Lithuania, Latvia and Estonia. Methuen & Co., Ltd., London, 1925.

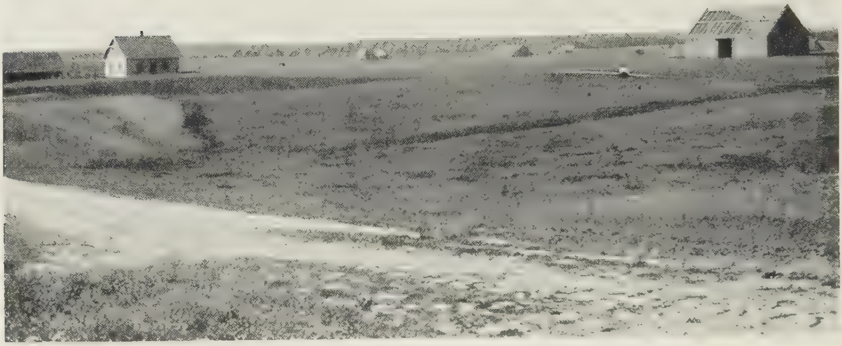

FIG. 7—Homes of new settlers upon the redivided estates in Latvia. Note the architectural departure from that of the pre-war type in Figures 5 and 6.

recency some of the experiences related would hardly occur to a traveler in Latvia now, for the country is progressing so rapidly that what may be true today may be quite otherwise tomorrow. However, Rutter's optimism for the future of Latvia is well founded, and anyone reading his account may confidently accept it as a fair cross section of actual conditions. It is equally worth while to those interested in a summary view of the other new Baltic States.

Bihlmans[21] presents a survey of economic developments in Latvia since 1918, accompanied by a thorough-going bibliography of the post-war literature. He relegates the pre-republic writings to the shelf of historical documents of little value, so far as concerns the happenings of revolutionary days. As a reference handbook upon Latvia Bihlmans' volume serves an important function. While the author does not attempt a detailed interpretation of the facts he presents, he is of the opinion that, successfully to develop industrially or agriculturally, Latvia must acquire capital upon favorable terms and the people must be willing to sacrifice their personal desires in favor of the national welfare. He believes a unification of the business interests of Latvia, Estonia, and Lithuania would lend strength to all and would conform to the physical conditions of these three countries, which naturally constitute a unit.

For those who have an interest in the details of Latvia's financial structure and the distribution of her trade among the nations, Siew[22]

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[21] Alfred Bihlmans: Die politischen und wirtschaftlichen Grundlagen der Baltischen Republik Lettland. (Bibliothek des Baltischen Ostdienst-Verlages für Wirtschaft und Recht.) Riga, 1926.

[22] B. Siew: Lettlands Volks- und Staatswirtschaft. Jonck & Poliewsky, Riga, 1925.

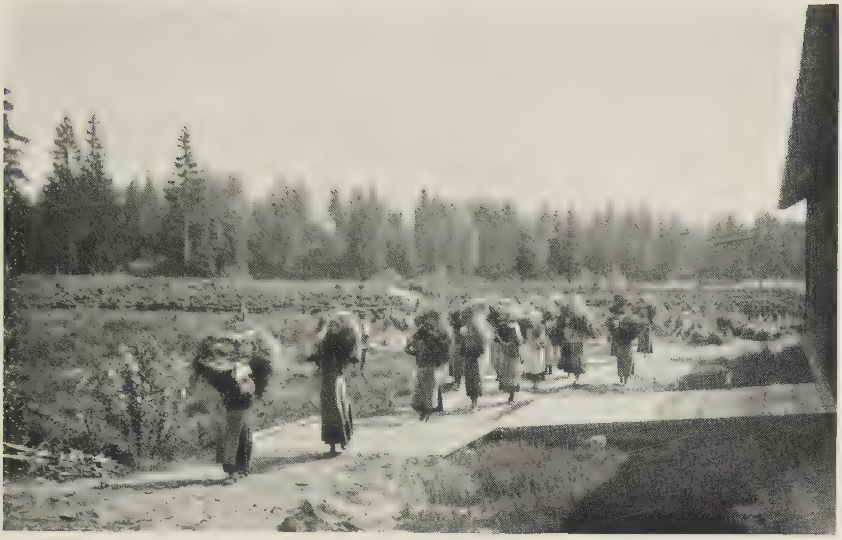

FIG. 8—Flax harvest in Latvia. Flax is one of the country's most dependable and valuable crops, offering direct returns to farmer and industrialist.

offers a comprehensive report. It has been prepared to meet the numerous inquiries for these data, many of which have heretofore been available only in the Lettish language or in Russian.

INDUSTRIAL PROBLEMS

Both Estonia and Latvia have their industrial problems, which have exerted an important influence upon their agriculture. Their climate is not particularly conducive to a large variety of crops. They possess important timber lands though not nearly so extensive as those of Finland. Mineral resources are quite restricted, although Estonia has oil shale deposits which are proving a valuable asset. In pre-war days these countries produced goods largely for Russian consumption; but with that market gone, at least temporarily, either the industrial life must disappear or it must turn to commodities which other markets may consume and where competition permits.

The European demand for butter fats after the war presented an opportunity to these northern countries; and as a consequence they have shifted their agriculture to dairying and the raising of only enough of grains for local needs, while at the same time the manufacture of butter and some cheese has developed into a new and important industry. "L'industrie laiterie en Lettonie," Riga, 1926, an attractive government pamphlet describing the dairy industry in brief, offers a striking picture of the rise, at a seemingly unprecedented rate, of a new national industry. The reports of the Department of

Overseas Trade on the economic and industrial conditions in Estonia[23] and Latvia[24] respectively, make available statistical data, with some interpretation, revealing the high rank of butter and animal products in the export trade of these countries. They also direct attention to the fact that while both countries in pre-war days constituted primary transit districts for Russia's trade, today much of that trade is lost. In this status the British government has a particular interest inasmuch as it looks forward to the possible return of Russian trade through the ports of Tallinn (Revel) in Estonia, and Riga, Libau, and Windau in Latvia, for which business Germany will offer keen competition. It is of interest to note that a Draft Agreement for a Customs Union between Estonia and Latvia was signed at Riga in January last.

Lithuania

"Lithuania is essentially an agricultural country, over 80 per cent of the population being employed on the land, and its future existence must depend to a very large extent on the successful development of its resources in that respect."[25] This well summarizes the situation, and the statement is confirmed by the close correspondence between harvest and trade balance. Like Latvia, the government is devoting considerable energy to the organization of its agriculture, encouraging the peasantry to engage in dairy farming and the raising of swine, eventually to export "butter, cheese and pork in place of grain."

Dr. Hans Mortensen,[26] in a scholarly geographical study of Lithuania, makes the unqualified assertion, "agriculture is the most important industry of Lithuania. . . Over half of the population of Lithuania consists of farm owners, and 76.8 per cent of the population lives in the rural districts." He points to the fact that farm productivity is low, owing both to the short growing season and poor natural drainage, the latter remaining as yet untouched by any effort to improve it mechanically. Aside from limited forest products Lithuanian territory "yields essentially nothing" for industry. Such industries as do exist are exceedingly small and inconsequential.

While Mortensen appears somewhat pessimistic as to Lithuania's future, a view undoubtedly prejudiced to some extent by his German background, Rutter sees a brighter horizon. The agrarian reform has banished Bolshevism and given agriculture a new life. The government is not only studying agricultural methods abroad but bringing into the country farmers from elsewhere to develop model farms and serve as illustrations to the nationals of what can be accomplished under proper procedure.

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[23] H. M. Grove: Report on the Economic and Industrial Conditions in Esthonia. Department of Overseas Trade, H. M. Stationery Office, London, 1925.

[24] J. Lowdon: Report on the Economic and Industrial Conditions in Latvia, Department of Overseas Trade, H. M. Stationery Office, London, 1925.

[25] H. H. Cassells: Report on the Economic and Industrial Conditions in Lithuania. Department of Overseas Trade, H. M. Stationery Office, London, 1924.

[26] Hans Mortensen: Litauen: Grundzüge einer Landeskunde. Osteuropa-Institut in Breslau. L. Friederichsen & Co., Hamburg, 1926.

Polish Boundary and Memel Territory

Lithuania suffers a special handicap in that her boundary with Poland has not yet been settled, since she refused to accept the line drawn by the Council of Ambassadors in 1923 which gave Vilna to Poland. The fact that there are no relations, political or economic, between Poland and Lithuania has a particularly prejudicial effect on the Memel Territory. Little timber is being floated down the Niemen; and the sawmills, the chief industry of the Territory, are largely idle.

It is difficult to find a concise unbiased account of what actually took place in the transfer of the Memel Territory. An illuminating, though biased, description is given by Rolf Schierenberg.[27] He supports his contention with documentary evidence, but his viewpoint is colored by his intense German patriotism. The dispute was settled by the Convention signed at Paris, May 8, 1924. Article 2 of the Convention[28] provides that the "Memel Territory shall constitute, under the sovereignty of Lithuania, a unit enjoying legislative, judicial, administrative, and financial autonomy" within certain prescribed limits. The Port of Memel is considered as a port of international concern, and the recommendations of the Barcelona Conference are stated to be generally applicable. Naturally enough the affairs of this old German port are not yet in smooth working order. Moreover, apart from questions of administration, there is the need of developing the port for general trade as well as timber export and of providing better communications with Lithuania as a whole. It now is a thirteen-hour journey by rail from Memel to Kovno, and the line crosses Latvian territory.

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[27] Rolf Schierenberg: Die Memelfrage als Randstaatenproblem. Kurt Vowinckel Verlag, Berlin-Grünewald, 1925.

[28] League of Nations Treaty Series, Vol. 29, 1924, No. 736.

SOME UNUSUAL SUBMARINE FEATURES IN THE NORTH PACIFIC OCEAN*

Commander N. H. Heck

U. S. Coast and Geodetic Survey

THE rim of the Pacific, including both the shores and the adjacent waters, is one of the most interesting parts of the earth from many viewpoints but especially in that it is the part of the earth where the processes of change to which all the rest of the earth has been subject at one time or another are in most active progress. To describe all the features of interest would require a volume. This paper is intended to bring out some of the less-known features, chiefly submarine.

It was known that along the coast of Mexico and Central America there existed a deep submarine trough, the Acapulcograben of the German charts; but not till the cruise of the Coast and Geodetic Survey Steamer *Guide* in 1923 were the extent and maximum depth of the trough known. This vessel, using the sonic depth finder, was able to make a survey in a short time which, though far from exhaustive, outlined a series of troughs extending from Costa Rica to the Gulf of California with an average width of 40 miles, a total length of 900 miles, and a greatest depth of nearly 3600 fathoms (Fig. 1). While there are much greater deeps, it is noteworthy that on both sides of this trough the depth is very much less than that of the trough, in some cases not more than half.

The earthquake epicenters from the Summary of the British Association for the Advancement of Science 1899 to 1917, from the International Seismological Summary 1918 to 1922, and from records of the Coast and Geodetic Survey after that date were plotted and are shown in Figure 1. Fifteen epicenters are in or near the trough, and half a dozen more may easily have been near it but are located with uncertainty. There is another series which lines up with a series of oceanic islands and reefs, including Guadalupe Island, the Alijos Rocks, and the eastern Revillagigedo Islands. The absence of a deep trough off the California coast and the practical absence of earthquakes except in the seaward continuation of the San Andreas fault are significant.

Passing to southeastern Alaska we note in Figure 3 the outline of what is presumably a volcanic crater, for it is difficult to explain a circular cavity of such dimensions on any other assumption. The crater lies off Prince of Wales Island.

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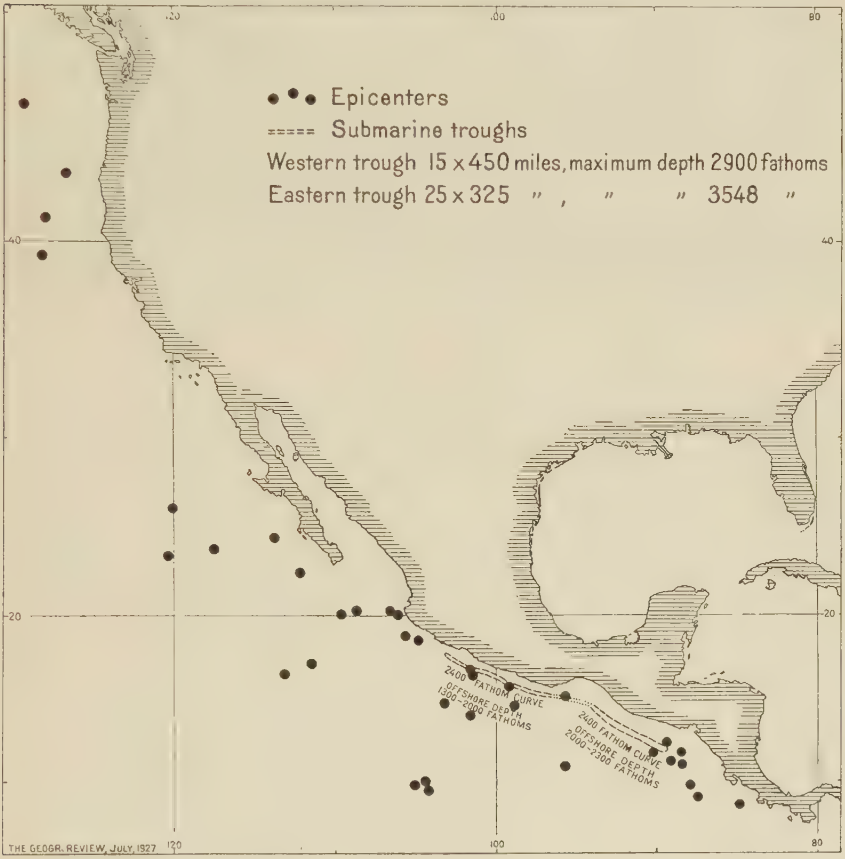
*Paper presented before the Geological Society of Washington on March 24, 1926.

A geological feature of considerable importance is the pinnacle rock, probably found in greater height off the Alaska coast than elsewhere. Figure 2 shows such a rock exposed to view, but the wire drag work of the Coast and Geodetic Survey has established the existence of a considerable number of these rocks as submarine features. One of these is 600 feet in height, extending from a bottom of general depth of about 100 fathoms nearly to the surface. Fortunately for navigation, the Coast and Geodetic Survey has dragged all the main channels, so that possible danger of sudden destruction of vessels from this cause is confined to some of the unsurveyed bays.


● ● ● Epicenters
===== Submarine troughs
Western trough 15 x 450 miles, maximum depth 2900 fathoms
Eastern trough 25 x 325 " , " " 3548 "
2400 FATHOM CURVE
OFFSHORE DEPTH 1300-2000 FATHOMS
2400 FATHOM CURVE
OFFSHORE DEPTH 2000-2300 FATHOMS
120
100
80
40
20
40
20

THE GEOGR. REVIEW, JULY, 1927

FIG. 1—Epicenters off the Pacific coast of the United States, Mexico, and Central America. The submarine troughs off the southern part of these coasts measured by the sonic depth finder in 1923 are also shown. The existence of a connection between the troughs is doubtful but possible.

Yakutat Bay is famous for the great vertical displacement that occurred there at the time of the earthquake in 1899. The change

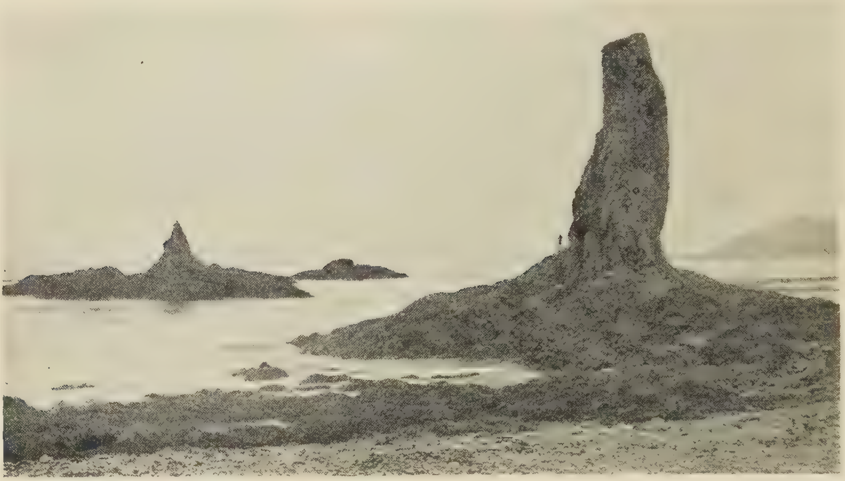


FIG. 2—Pinnacle rocks near Cape Spencer, Cross Sound, Alaska.

of height, 49 feet, was in solid rock and is the greatest known in such material; the greater submarine changes mentioned later were, undoubtedly, in poorly consolidated materials. In Bristol Bay north of the Alaska Peninsula, Besboro Island, obviously part of the rim of a crater, now rises to 1600 feet in a generally flat region.

Passing west along the Aleutian Islands, Bogoslof Island is the one island under United States jurisdiction whose making has been witnessed, the eruption which caused it to rise from the sea having been observed by members of the U. S. Coast Guard.

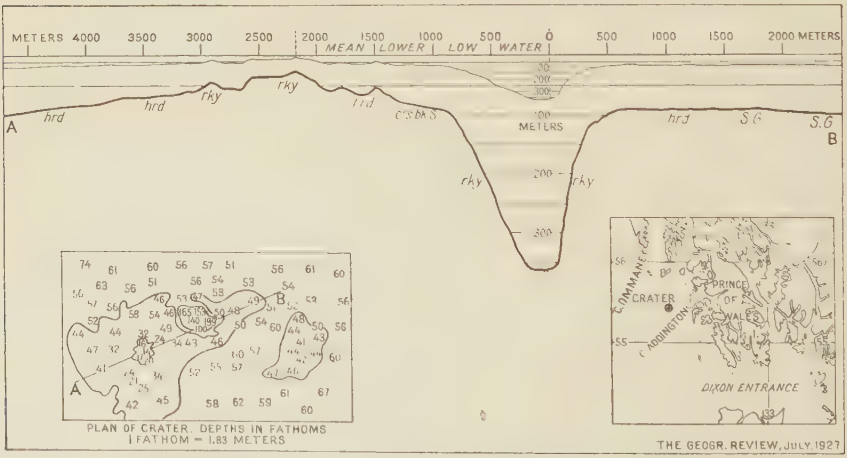


FIG. 3—Submarine crater west of Prince of Wales Island. Situation of the crater is shown in the inset map on the right: a map of the crater appears in the inset on the left. The section across the crater is along the line A–B of the plan. The upper (light) line is drawn to true scale: in the lower (heavy) line the vertical scale has been exaggerated five times.

In Figure 4 the axis of a great deep that parallels the Aleutian Islands is shown. Our knowledge of this deep is based on not more than twelve soundings; but, as all of these are more than 4000 fathoms and all line up properly, there seems little doubt as to the continuity. It is of special interest that this deep apparently continues to the coast of Alaska following a submarine valley to Yakutat Bay. It will be seen from Figure 4 that a number of epicenters are associated with this deep, especially on its southern edge; while these are few compared with the deeps on the western side of the Pacific, an unusually large proportion are of the world-shaking type.

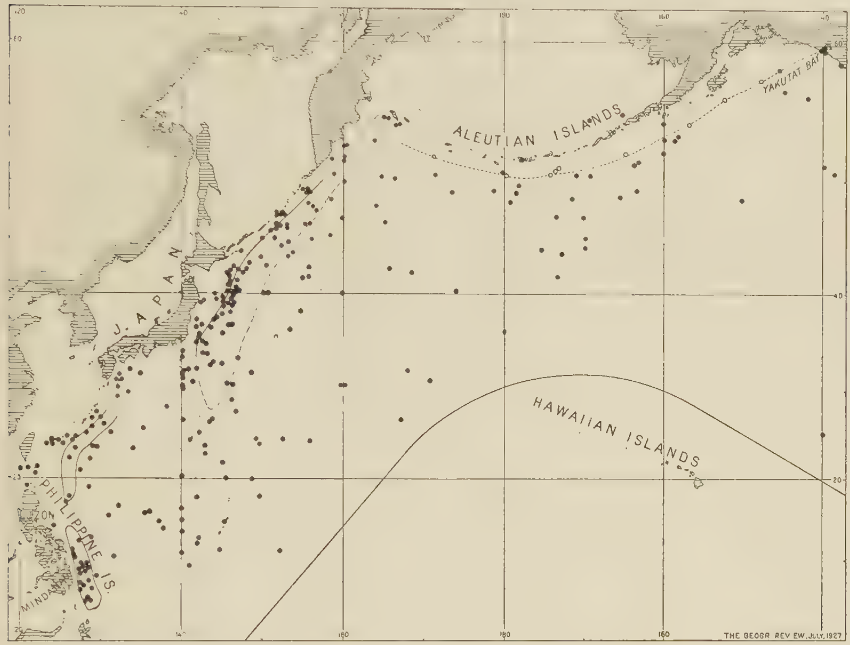


FIG. 4—Epicenters of the north Pacific Ocean. Earthquakes occurring south of the line about the Hawaiian Islands have not been plotted. The line of open circles from Yakutat Bay paralleling the Aleutian Islands represents soundings which define the axis of a great deep.

Little is known as to the character of the bottom between the Aleutian and the Hawaiian Islands, and it is difficult to understand the wide distribution of epicenters in what should apparently be a flat ocean basin.

The association of epicenters with the deep troughs is well brought out in the great trough extending from northern Kamchatka to the southern part of the main Japanese group. It is, of course, true that there are many epicenters inshore from these deeps and also on the land, but it is without argument that the deeps are closely associated with major earthquake activity. The features that have been discussed bring out strongly the need for more detailed surveys of the

North Pacific, especially as immense regions are still without a sounding. With echo-sounding available, the excuse for such a situation no longer exists.

The deep east of the Philippines, which has one of the deepest soundings known, is particularly interesting in that all the epicenters occur in the deep. Earthquakes occur on land in considerable numbers, but almost invariably the greater ones are associated with the Mindanao Deep.

The change in Sagami Bay, accompanying the earthquake of September 1, 1923, is the greatest that has been known to have occurred in a single earthquake. By surveys before and after, it is fairly well established that, though some of the early conclusions of almost unbelievable changes are not fully justified, changes of as much as 100 feet occurred in a number of cases and much greater changes in a few cases. It appears to be the opinion that these great changes occurred chiefly in soft material probably of volcanic origin, as the adjacent rocky shores were changed in few cases more than ten feet, the average being much less.[1]

Another illustration of the advantage of accurate surveys in detecting submarine changes is found in the case of a sudden change of depth in the Zulu Sea near the Cuyo Islands, when an area of half a square mile dropped an average extent of 100 feet between two surveys eighteen months apart. This case is described in full in an article in the *Geographical Review* for April, 1926, by Lieutenant Commander F. H. Hardy of the Coast and Geodetic Survey.

In order that geologists and geographers may be able to attack in an adequate manner the problems of the Pacific it is obvious that deep-sea surveys extending over the entire ocean and also detailed surveys of the coastal waters are urgently needed so that changes may be detected. Such a survey would have been of great value in the case of the Yakutat Bay earthquake, where there was no adequate survey either before or after. The steady and rapid extension of surveys of hitherto unsurveyed area is removing the probability that this will occur again.

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[1] Compare the note "Physiographic Effects of the Japanese Earthquake of 1923" by Professor W. M. Davis, elsewhere in this number of the *Review*.

THE UTILIZATION OF THE COLORADO RIVER

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IN the early development of a country rivers are useful mainly as avenues of travel. They are highways to the interior which lure the adventurer and the pioneer. Later, when the land becomes settled, they may or may not retain this primal use. Now protection is demanded from the ravages of the river, and the property and the life of the riparian settler must be safeguarded. Later, when great cities grow in the basin, heavy demands for water for domestic purposes arise; and power for lighting, transportation, and manufacturing is called for. Of all the uses of the river, which are paramount and which are subservient? If two or more can be developed, which should have the preference? Under what conditions do the uses of a river conflict?

The St. Lawrence River, which directed the travels of Champlain, Hennepin, and Marquette, maintains its preëminence as a highway. Its future development involves a great extension of the facilities of navigation and commerce. Because the Great Lakes form natural reservoirs, flood menaces are insignificant along the St. Lawrence; its falls yield alike scenic beauty and power to turn the wheels of distant factories; from its waters are drawn the domestic water supply of great cities. Yet even this stream, well adaptable to a varied utilization, presents its problems, notably in the conflict over diversion at Chicago.[1]

The Mississippi River, lying athwart the pathway to the west, has less historic importance. Great areas adjacent to the river are subject to overflows, and a levee system to protect property and life has been devised, which under normal flood conditions is successful. Levees are not generally constructed to cope with unusual flood conditions such as occurred in the lower Mississippi Valley in the spring of this year (1927). The Mississippi became a highway, but traffic was never large and has declined.[2] At high water the wash of the boats is at times dangerous to the levees, and navigation at these times becomes subservient to protection. Navigation is likewise hampered by low water stages of the river. There are no natural reservoirs, as there are in the St. Lawrence System, and the building of artificial reservoirs to withhold the flood waters and to raise the low water stage is, in view of the light traffic, not considered a profitable enterprise. The great dam at Keokuk, Iowa, is an example of the use of this stream for power purposes. The Mississippi River as now regulated under normal conditions fulfills most of the uses of a river without conflict, and with sufficient funds it could perform all.

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[1] Compare P. W. Henry: The Great Lakes-St. Lawrence Waterway, *Geogr. Rev.*, Vol. 17, 1927, pp. 258–277.

[2] Robert M. Brown: Our Waterway Requirements, *Geogr. Rev.*, Vol. 5, 1918, pp. 119–126.

But these streams are in the humid belt with an ample supply of water, and the question of priority of rights is less apt to arise under these conditions. In the case of the Colorado River in the arid Southwest, it would seem that there is not an ample supply of water for all purposes. In addition to the demand for domestic uses within the basin two large population centers outside of it look here for a means of satisfying their growing needs, and there is a call for water for irrigation and power. Flood ravages and low water stages are halting development. Navigation, which at one time was carried on to some extent between the Gulf of California and the old town of Callville at the lower end of Boulder Canyon, is not an issue on the Colorado as the shifting sands make such travel uncertain.

On the Tennessee River the government built as a war measure the Wilson Dam at Muscle Shoals. This great power plant is today an economic waste because there has been injected into the issue the question of the distribution of power. It is widely conceded that power developed on any stream should belong to the region and should not be monopolized by a few industries. It is obviously wrong that there should be local monopolization of the Niagara River power while the city of Buffalo uses steam-generated power. The main problem in the Southwest, the proper utilization of the waters of the Colorado River, is somewhat befogged by the issue of government ownership of power-generating plants. Meanwhile, the prosperity of the irrigated lands, such as the Imperial Valley, is threatened, and conditions in seven states in the Colorado basin are growing more acute. Furthermore, the Colorado is an international stream.

The Basin and River

The basin of the Colorado River, comprising 244,000 square miles, or 156,160,000 acres, may be divided into three distinct regions. An upper basin in Colorado, New Mexico, Utah, and Wyoming lies between the Wasatch and the Rocky Mountains, and these ranges with their heavy precipitation, especially in the form of snow, supply over 75 per cent of the flow. Over the valleys of the upper basin the rainfall at places is less than ten inches, but with irrigation the valleys are well adapted to agriculture and with power to manufacture.

The plateau section, extending from Lees Ferry to Grand Wash Cliffs, has a general elevation of 5000 to 8000 feet, is cut by deep gorges and canyons, and is in the main inaccessible. No part of this area is easy of irrigation: the chief characteristic of the region is the fall of water, 2500 feet in less than 500 miles, and the possibility thereby of concentrated water power sites.

The lower basin in the states of Arizona, California, and Nevada and in Mexico, for the most part only a few feet above sea level, is arid with an annual precipitation ranging from an inch and a half to eight inches a year and temperatures ranging from 32° to 120°. In the Salton basin a temperature of 130° F. has been recorded.[3] The potentiality of the lower basin rests entirely on crops from irrigation. The greater portion of the irrigated area lies in Imperial Valley, as the cultivable portion of the Salton basin, is called. This region is separated from the actual basin of the Colorado by a deltaic ridge built up by the river itself. The basin, which occupies a million or more acres, is below sea level and a hundred feet below the Colorado River. The natural and easy possibilities of irrigation began to attract settlement here a quarter of a century ago. By 1910 Imperial County, California, had a population of 13,591, in 1920 of 43,453. The annual value of products raised in the Valley today amounts to between $40,000,000 and $50,000,000.

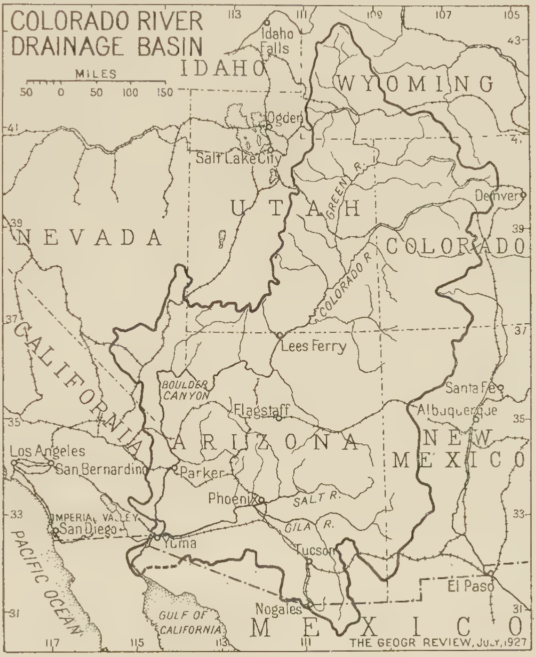

Fig. 1—The drainage basin of the Colorado River. Scale 1 : 17,500,000.

The prosperity of the area is constantly threatened by the danger of inundation during floods.[4] There is also some concern over water shortage during dry seasons. In 1924 a loss totaling millions of dollars was sustained by the farmers in the Imperial Valley because of lack of water. Table I, prepared by the U. S. Bureau of Reclamation, gives irrigated and irrigable areas of the entire basin of the Colorado on the basis of the latest data available.

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[3] John S. Brown: The Salton Sea Region, California, *U. S. Geol. Survey Water Supply Paper 497*, Washington, 1923, p. 13.

[4] For a recent discussion of the instability of conditions in the Colorado Delta see Godfrey Sykes: The Delta and Estuary of the Colorado River, *Geogr. Rev.*, Vol. 16, 1926, pp. 232–255. For special reference to the Imperial Valley see J. H. Gordon: Problems of the Lower Colorado River, *Monthly Weather Rev.*, Vol. 52, 1924, pp. 95–98.

The Colorado's dominant characteristics lie in its profile (see Fig. 3), and its silt-bearing proclivity. The river is 1700 miles in length and falls 8000 feet, or, eliminating the expectable steep slope of the headwaters from Green River, Utah, to the Gulf of California, 1000 miles, there is a drop of 4000 feet. For half this distance the river flows in a canyon which furnishes innumerable dam sites. When one considers other power-yielding streams in the United States, as the Tennessee River with its Muscle Shoals power site and a drop of 460 feet from Knoxville to Paducah, approximately 700 miles, the potential power of the Colorado appears spectacular. As regards the concentration of water-power sites in North America, only the Columbia and St. Lawrence basins present greater possibilities. According to Bureau of Reclamation estimates at Yuma the river carries about 100,000 acre feet of silt annually. With a flow of 17,000,000 acre feet of water the silt content is approximately 0.6 per cent of its volume.

Irrigation from a high silt-bearing stream is troublesome. As the water passes into the irrigation canals, the reduced velocity of the flow causes heavy deposits in the trenches, and in a short period the capacity of the canals is considerably lessened. The development companies have spent thousands of dollars annually in the Imperial Valley to keep the flow of water in the canal systems in full operation. Dredges are in constant use. A series of dams would reduce the silt-bearing capacity of the river and overcome this trouble. A single reservoir low on the river, as at the Mohave dam site, would protect the irrigation canals from this stoppage; but it is problematical whether or not within a few years the original capacity of the reservoir would be affected if used as a catch basin for silt.

THE COLORADO COMPACT

Parts of Wyoming, Utah, Colorado, New Mexico, Nevada, and California and almost the whole of Arizona lie in the Colorado basin (Fig. 1). As already indicated, the interests of the several states in the water of the basin are divergent, and some form of coöperation is necessary for the best utilization of the waters. Under an Act of Congress approved August 19, 1921, the representatives of the states of Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming met to determine the allocation of the right to the waters of the Colorado River and signed on November 24, 1922, the Colorado River Compact.[5]

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[5] For the text of the document see *67th Congr., 4th Sess. House of Repr. Doc. No. 605*. It may be found also in "The Colorado River Compact," by R. L. Olson (Los Angeles, 1926) which gives a useful analysis of the compact and includes also a considerable body of documentary material.

The Compact names as major purposes "to provide for the equitable division and apportionment of the use of the waters of the Colorado River System; to establish the relative importance of different beneficial uses of water; to promote interstate comity; to remove causes of present and future controversies; and to secure the expeditious agricultural and industrial development of the Colorado River Basin, the storage of its waters, and the protection of life and property from floods." The area involved is defined as the drainage basin of the Colorado River and its tributaries within the United States and all other territory within the United States to which these waters "shall be beneficially applied." This area is divided into an Upper and a Lower Basin, the dividing point being Lees Ferry, "a point in the main stream of the Colorado River one mile below the mouth of the Paria River."

TABLE I—IRRIGATED AND IRRIGABLE AREAS IN THE COLORADO BASIN

(*Areas in Acres*)

	IRRIGATED 1922	ADDITIONAL IRRIGABLE	TOTAL
Upper Colorado Basin	1,447,000	2,740,000	4,187,000
Lower Colorado Basin	521,000	1,467,000	1,988,000
Gila Basin	430,000	400,000	830,000
Totals	2,398,000	4,607,000	7,005,000
Colorado above Boulder Canyon	1,499,000	2,820,000	4,319,000
Colorado below Boulder Canyon	469,000	1,387,000	1,856,000
Gila Basin	430,000	400,000	830,000
Totals	2,398,000	4,607,000	7,005,000
Wyoming	235,000	522,000	757,000
Colorado	800,000	1,460,000	2,260,000
Utah	386,000	377,000	763,000
Nevada	7,000	7,000	14,000
New Mexico	50,000	408,000	458,000
Arizona	493,300	1,312,700	1,806,000
California	426,700	520,300	947,000
Totals	2,398,000	4,607,000	7,005,000

Under the Compact each of the two basins of the river is apportioned the use of 7,500,000 acre feet of water a year. The lower basin has an additional privilege of increasing its use by 1,000,000 acre feet a year. Provision is also made for the results of any agreement by the United States as to the rights of Mexico to the use of the waters of the Colorado.

The use of the waters for navigation is made subservient to its uses for domestic, agricultural, and power purposes. The Compact provides for the impounding and use of the waters for the generation of electrical energy, but such a use is in turn subservient to the use and consumption for agricultural and domestic purposes.

At the time of the signing of the Compact, the seven states were agreed upon the mutual benefits to be derived from it. Gradually as more facts and conditions were considered there has been a tendency, led by Arizona, to discount the advantages of the main provisions of the Compact.[6] Utah rescinded its ratification early in 1927, and California's adherence is conditional on the building of the Boulder Canyon dam. The Compact, it should be noted, does not make reference to any specific project. In general a vague feeling of impending loss most accurately explains Arizona's attitude. The Fourth Arizona Legislature (1919) created the Arizona Resources Board, with full power to investigate and secure such information as would aid in estimating the amount of irrigable land in the state. The Fifth Arizona Legislature (1921) created a Water Commissioner whose immediate duty was the securing of information as to the possibilities of the development of the Colorado River. Governor Hunt in his message of January, 1923, stated that very little information of a constructive nature is available as a result of these acts.

The Boulder Canyon Project

From a point about 150 miles below El Tovar Hotel on the Grand Canyon the Colorado River for another 150 miles forms the boundary between the states of Nevada and Arizona. The country along this stretch of the river is rugged, and the river alternately flows through open valleys and canyons. From Mohave City, 238 miles from Yuma, the river continues as the boundary between California and Arizona. The first of the irrigable areas lies at Parker, 152 miles above Yuma. The initial recommendation for the regulation of the Colorado River is the so-called Boulder Canyon project now before Congress. This includes the construction of a dam at Black Canyon or Boulder Canyon "adequate to create a storage reservoir of a capacity of not less than twenty-six million acre-feet of water," a canal "located entirely within the United States" connecting the Laguna Dam or other diversion works with the Imperial and Coachella valleys, and construction for "the fullest economic development of electrical en-

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[6] Official Report of the Proceedings of the Colorado River Conference between Delegates Representing California, Nevada and Arizona, at the State Capitol, Phoenix, Arizona, Monday, August 17th, 1925, Phoenix, Ariz., n. d.

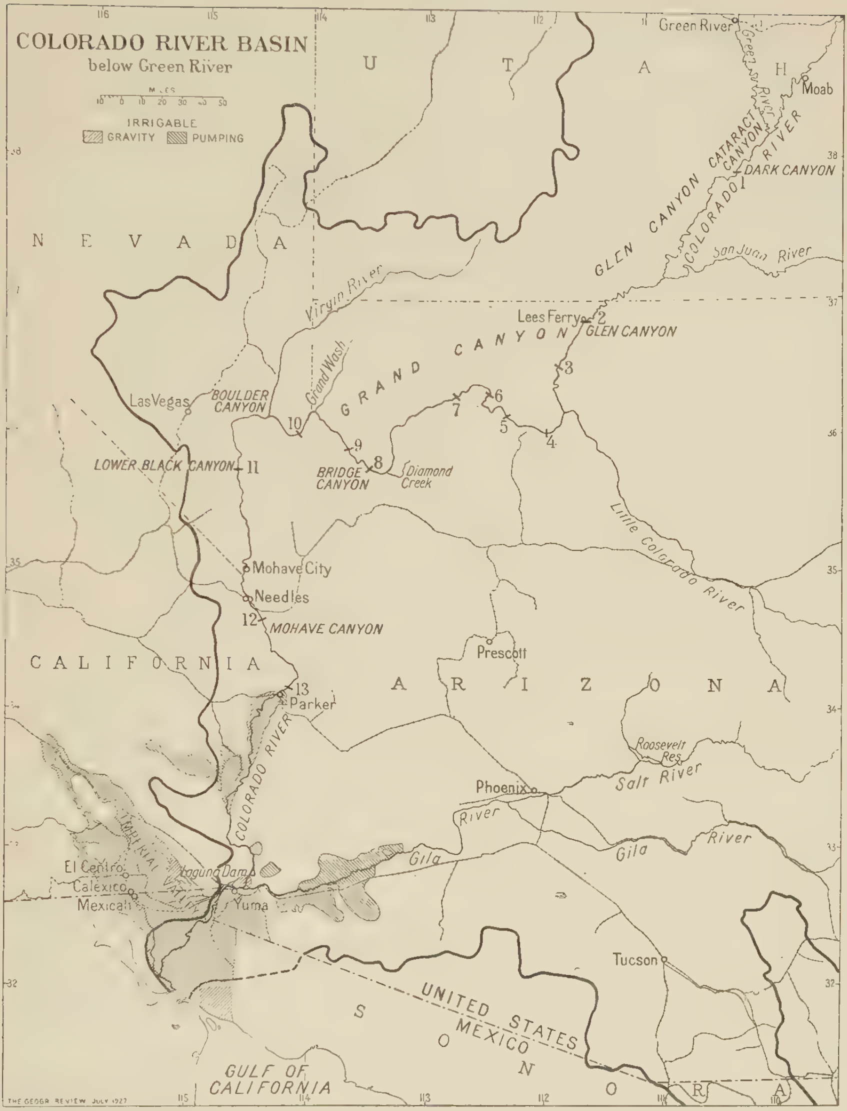

FIG. 2—The Colorado River drainage basin below Green River, Utah. From Pl. II of *U. S. Geol. Survey Water-Supply Paper 556*, by E. C. La Rue (see footnote 10). The numbers have reference to proposed water-power sites: compare Fig. 3 and Table II. Irrigable lands below Parker are shaded, the angle of shading indicating the type of irrigation. Scale 1 : 6,000,000.

ergy."[7] A clause also makes the undertaking contingent on the adherence of "at least six of the signatory states" to the Colorado River Compact.

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[7] Colorado River Basin: Hearings before the Committee on Irrigation and Reclamation, House of Representatives, Sixty-ninth Congress, First Session on H. R. 6251 and H. R. 9826 by Mr. Swing: Bills to Provide for the Protection and Development of the Lower Colorado River Basin, Part 2, Washington, 1926, p. 85.

Boulder Canyon is 342 miles above Yuma, Black Canyon 311 miles. The Bureau of Reclamation approves a dam at Black Canyon 550 feet above the river level. To appreciate this magnitude it may be recalled that the Roosevelt dam is 280 feet, the Shoshone 324 feet, and the Arrow Rock 349 feet. The last exceeds the height of any other dam in the world by 14 feet. The cost of the proposed reservoir, ample for the storage of over a year's accumulation of water, is estimated at $41,500,000; of the power development, at $31,500,000; and of the canal, at $31,000,000. The total with interest is $125,000,000. The annual income from the sale of power is estimated at $10,800,000. Need for the proposed all-American canal is stated to depend largely on whether the existing concession under which water is now diverted and carried through Mexico to the Imperial Valley can be modified: "if it can not be then the all-American canal becomes an indispensable part" of the development.[8] The discussions over the Compact and the hearings of the Boulder Canyon bill reveal the difficulties inherent in the problem of the Colorado River regulation.

THE ADEQUACY OF THE WATER SUPPLY

The first question that arises is the adequacy of water in the Colorado basin to the present and prospective demands. In addition to the needs of the basin itself, Denver and Los Angeles are looking to the river as a supplementary water supply for domestic purposes—the one from the Upper, the other from the Lower Basin, which in itself might prove a source of trouble between the two sections.[9] Los Angeles and the group of surrounding cities are particularly insistent, since their continued rapid growth is now threatened by lack of water. With 7,500000 acre feet allocated to the Upper Basin, there is left 8,500,000 acre feet for the Lower Basin. The United States Geological Survey[10] estimates that at Parker, where the water is first turned from the river for use, the annual supply available will be about 9,593,000 acre feet. Irrigable land below Parker and within the bounds of the United States totals 2,304,000 acres, which will demand 9,909,000 acre feet of water. In Mexico at least 1,000,000 acres are irrigable and would require 3,357,000 acre feet. Requirements of southern California for domestic uses are placed at 2000 seconds feet of water, equivalent to an annual total of 1,448,000 acre feet. Thus the total amount which the present-day conditions anticipate is 14,714,000 acre feet; and if the estimates are correct, there will be an annual shortage of 4,805,000 acre feet of water in the Lower Basin.

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[8] Report by Secretary Work quoted in *New Reclamation Era*, Vol. 17, 1926, p. 21.

[9] Olson points out a certain "sectionalism" between the western and eastern divisions of the state of Colorado itself, *op. cit.*, p. 177.

[10] E. C. La Rue: Water Power and Flood Control of Colorado River below Green River, Utah, *U. S. Geol. Survey Water-Supply Paper 556*, Washington, 1925.

Inadequacy of the water supply for the Lower Basin and fear that an insufficient amount of water would be allocated to the state are the basis of Arizona's protest against the Colorado Compact and its determination to oppose the Swing-Johnson Boulder Canyon bill. In his message to the Sixth State Legislature Governor Hunt of Arizona stated that the allocation of 4,000,000 acre feet of additional water to the Upper Basin (the present use is about 3,500,000 acre feet) would be an economic waste and that grave injustice is done to Arizona in the apportionment of the waters. The Colorado Compact, on the other hand, states after apportioning the waters between the Upper and Lower Basins that the states of the Upper Division shall not withhold water which cannot reasonably be applied to domestic and agricultural uses.

Water Rights in the Arid West

By common law, if no specific provisions to the contrary have been enacted, an owner of land immediately adjacent to a non-navigable stream owns the bed of the stream to the middle of the current: In this primary consideration it is held that the land only is owned, not the water in the stream, since water is not deemed capable of private ownership. A riparian owner, however, is granted the right to use the waters of a stream flowing through his land in any way and to any extent that does not inflict substantial damage on other riparian owners. The interpretation in many communities has made this right applicable to use on that land only which is adjacent to the stream.

When irrigation began to be extensively practiced in the West and water was desired at a distance from the river, and when water began to be used for mining operations at locations apart from streams, the common law idea was by general consent broadly interpreted, and those who first appropriated water on the public lands and for mining were recognized as the owners of such waters. Later, by Act of Congress and by the statutes of various western states, this idea was incorporated into law. This principle of first appropriation is now the dominant basis of water rights in the arid West. Only in California is the doctrine of riparian ownership recognized—along with that of prior appropriation. Since there appears to be a dearth of water in the Lower Basin, it is not strange if the Lower Basin states look with apprehension upon the proportion of water allocated to the Upper Basin: and particularly since the principle of first appropriation carries with it in the popular mind a title in perpetuity.

The land in Arizona below Boulder Canyon capable of irrigation lies adjacent to the river in small parcels ranging from 200 acres, just below Eldorado Canyon, to 115,000 acres for the Yuma project. The total acreage of this land is 287,200; and the rate of 4 acre feet per acre for irrigation would require 1,148,800 acre feet of water annually. This could be obtained probably without difficulty from the annual supply estimated at Boulder Canyon of 9,610,000 acre feet; but Arizona is not sure that this is all the land that can be irrigated. Two projects,[11] the Parker-Gila Valley and the Arizona High Line Canal, may some day be feasible. The former will irrigate 765,000 acres in Arizona, and the latter 2,350,000 acres; together 3,115,000 acres, for which the entire annual supply of water at Boulder Canyon would be insufficient. At the present time the pro rata cost per acre of these projects is prohibitive.

Arizona declares her wish to stand by the law of prior appropriation, and she fears that in signing the Colorado Compact she will be signing away her future rights to utilize the resources of the Colorado River. She insists on her right as a sovereign state to maintain jurisdiction over the bed of the streams within her borders and over all the water that flows within her boundaries except as title has been acquired under existing laws.

International Complications

The Colorado River runs 110 miles through Mexican territory before emptying into the Gulf of California. The contract by which Mexico could claim one-half of all the water passing through the American-Mexican canal is now working hardships on the builders of the canal and the Imperial Valley cultivators. American irrigation companies financed the canal, built it, are maintaining it, and policing the levees. They are hampered in their maintenance, even to the extent of paying tariff charges on mules moved across the border for work on the canal. There is growing out of these conditions a feeling of injustice and particularly a fear that the American-Mexican canal in the future is not going to serve the Imperial Valley adequately.

Recently a large Spanish grant in Mexico was bought by an American syndicate, largely made up of Los Angeles financiers, and this grant is being placed under irrigation rapidly. Oriental laborers are employed at a very low wage, taxes are lower than in the United States, and water is cheaper; the combination produces cheaper goods on the Mexican side than on the American. Competition of this kind can be regulated, since the international border line separates the two; but the extension of irrigable lands in Mexico has limited and will continue to limit the amount of water received by the Imperial Valley cultivators through the American-Mexican canal, and heavy losses have been sustained, as in September, 1924, when the crops perished because of an inadequate water supply. And this promises to be more common in the future, unless relief comes.

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[11] Report Based on Reconnaissance Investigation of Arizona Land Irrigable from the Colorado River. Arizona Engineering Commission, 1922, 1923.

The situation becomes complicated and passes into the realm of manipulative special privileges. Arizona and Utah fear that California is seeking some advantage over the other states. The dissatisfaction over the Mexican agreement in the allocation of water in the American-Mexican canal, in the face of the fact that southern California interests are expanding Mexican lands, is, however, much less international than appears on the surface.

The Colorado Compact provides for future contingencies by assigning Mexico such waters as are surplus over the allotments to the Upper and Lower Basins; and, further, should the United States recognize at any future time the right to the use of more water, this additional water shall be taken share and share alike, from the assignations to the Upper and Lower Basins.

FLOOD CONTROL

That there is an immediate need for the flood protection of the Lower Colorado Basin and the Imperial Valley is scarcely to be questioned. The Boulder Canyon dam as proposed in the Swing-Johnson bill would take from five to ten years to complete. It is a comprehensive scheme designed to serve four purposes—flood control, irrigation storage, silt storage, and power development. A scheme on a comparable scale has not been tried before, and there is disagreement as to its merits.[12] Other expert engineering opinion favors separation of the problems of flood control and irrigation storage from that of power development for a more efficient use of the available water supply.[13] Three sites have been proposed for purely flood control reservoirs: Mohave Canyon, Glen Canyon, and Black Canyon.

The Glen Canyon[14] site, 680 miles above Yuma and above the Grand Canyon, would store 8,000,000 acre feet of water. Although it would not control the floods on the tributaries below its location, it is not believed that such floods would be a menace. The main advantage of this site lies in the power possibilities of the river, and it would be one of a chain of dams for such development (see Table II). If power is not to be developed it is inferior to the others as a flood-control site. This dam could be constructed in six years at a cost of $77,000,000.

Black Canyon site is 340 miles above Yuma and in close proximity to Boulder Canyon. Here again the question of power enters, and if it is deemed advisable to develop the Colorado as a power stream it would be unwise to neglect the Boulder Canyon site. The dam at Black Canyon, which would furnish ample flood protection, would also take six years; but the cost would be considerably less, $28,000,000.

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[12] Secretary Work announced on March 14, after failure of Congress to pass on the Boulder Canyon bill, that a "fact-finding" committee would be appointed to advise the government on the merits of the Colorado River development projects.

[13] La Rue, *op. cit.*, p. 71.

[14] Figures covering the description of these dam sites for flood control as well as the dam sites for power are taken for the most part from the paper cited in footnote 10.

The Mohave Canyon site is 202 miles above Yuma, and here a dam could be constructed in three years at an approximate cost of $26,000,000. It would have the same storage capacity as Black Canyon, 10,000,000 acre feet, and additional storage could be provided at a less cost than at any other site; at the same time it would more adequately protect the irrigated areas from flood than any other site. The Mohave reservoir would flood some lands that are irrigable; but, since there are more such areas than there is water to serve them, the point is negligible. The town of Needles (population 2807) is situated in the reservoir area and would have to be transplanted. If flood protection alone is desired the Mohave Canyon reservoir appears to be the one preëminently fitted to meet this need.

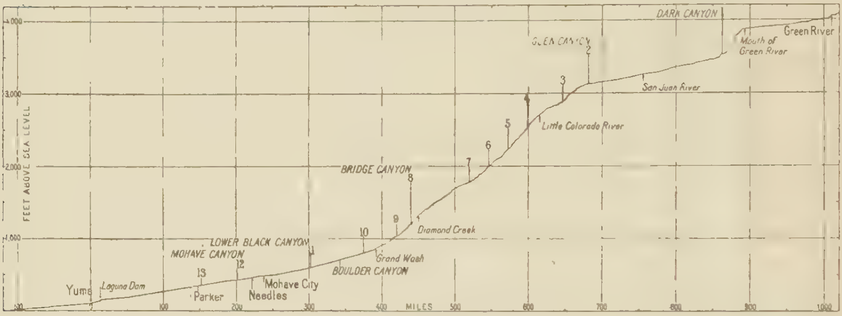

FIG. 3—Profile of the Colorado River below 4000 feet showing proposed dam sites. From Pl. III of *U. S. Geol. Survey Water-Supply Paper 556*, by E. C. La Rue (see footnote 10). Compare Fig. 2 and Table II.

WATER POWER

The full development of the water power of the Colorado River cannot at present be undertaken because of the enormous cost. At the same time it would be an unwise move so to regulate the flow of the river that future water-power construction is hindered or decimated, especially since adequate protection from flood may be obtained from a number of reservoir sites coördinated with the power plan.

The thirteen-dam plan for the development of power would yield a 3588 foot fall of water in 700 miles, as shown in Table II, with which should be compared Figure 3.

The total cost of all this construction would probably be prohibitive, at least for some time.[15] There is in addition the question of the demand for this amount of power in the region. Arizona, with a population density of 1.7 per square mile, offers by these projects a horse power of 50 per square mile: New England with a population density of 98 uses on the average 62 horse power per square mile.

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[15] The Federal Power Commission has been reported as opposed to dams on the Colorado River for power generation. In reality it is not, but it has suspended action on all applications except one at Diamond Creek until a settlement is made of the interstate compact so that licenses which are issued may be in accord with the terms of the compact.

TABLE II—SUGGESTED POWER DEVELOPMENT ON COLORADO RIVER BELOW ELEVATION OF 4000 FEET

DAM SITE	HEIGHT OF DAM IN FEET	HORSE POWER	MILES ABOVE YUMA
1. Dark Canyon . . .	512	672,000	862
2. Glen Canyon	386	557,000	682
3. Redwall	222	362,000	647
4. Mineral Canyon . .	345	588,000	600
5. Ruby Canyon . . .	286	495,000	573
6. Specter Chasm . . .	223	392,000	547
7. Havasu	209	387,000	520
8. Bridge Canyon . . .	566	1,090,000	440
9. Devil's Slide	163	311,000	421
10. Hualpea Rapids . .	225	483,000	375
11. Lower Black Canyon	194	375,000	303
12. Mohave Canyon . .	158	storage	202
13. Parker Canyon . .	99	70,000	154
	3588	5,792,000	

Southern California is mentioned as a market for much of the power. From Needles, on the Mohave site, to San Bernardino is 160 miles; to Los Angeles is over 200 miles; while the upper dam sites are more than 300 miles away. The famous transmission lines carry power no such distance: the Pacific Light and Power Company at Los Angeles transmits power about 250 miles; the Ausable Electric Company, Michigan, 245 miles; the Hydro-Electric Power Commission on Ontario, 135 miles; and the Mississippi River Power Company, 144 miles. For long-distance transmission the voltage must be high—the companies mentioned operate at from 110,000 to 150,000 volts—and this increases the cost of transmission lines.

CONCLUSION

An attempt has here been made to show the many sides of the Colorado regulation question. The advocates of one or another policy are many of them honestly trying to solve the problem to the greatest advantage. That there is some attempt by a few to drive a sharp bargain does not particularly affect the situation. There are flood protectionists who see only the need of impounding the water; there are power advocates who dislike to see the waste of energy; and there are water-supply protagonists who desire the cultivation of all the irrigable lands that can possibly be brought to blossom. To this triumvirate may be added the sectional groups somewhat dominated, as is natural, by jealousy and suspicion, and then the problem of the Colorado River is before us.

GEOPHYSICAL PROBLEMS OF GENERAL INTEREST

A SURVEY OF RECENT LITERATURE

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SOME of the most abstruse problems that confront students of earth sciences concern the constitution, structure, and physical behavior of the inner earth. The interest and importance of these matters are far-reaching, as the major surficial features of the globe, on which depend the welfare and the very existence of man, will never be understood properly without knowledge of the invisible interior. Quite certainly the great surface inequalities—ocean basins, continents, plateaus, and mountains—are not the result of mere chance. They reflect conditions and forces in the deeper zones of the earth, far beyond the range of direct observation. What is the mechanism by which large relief features have been made and maintained? What has been the relation of continents and oceans in the past? Recent attempts to answer these stubborn questions use data from geology, physics, chemistry, geodesy, mechanics, and seismology, with a generous admixture of assumption. As might be expected, the results are widely at variance. However, the discussions from various viewpoints reveal a considerable body of accepted fact and inference.

VIEWS OF JEFFREYS

Outstanding among the recent geophysical contributions is a British book with the comprehensive title "The Earth," by Harold Jeffreys.[1] In this work mathematics and lucid English are combined very happily, so that readers who find the mathematical treatment too formidable may do judicious skipping and still follow the main argument. Starting with cosmogonical considerations, Jeffreys rejects the Laplacian hypothesis as to the origin of the solar system and adopts the idea of tidal solar disruption which was brought into prominence by Chamberlin and Moulton and later modified by Jeans. Jeffreys thinks it probable that the disrupted gaseous material formed rapidly into a few large spheroidal bodies, which condensed to the liquid state and, in the case of the smaller masses, finally solidified. Thus his hypothesis insists on a liquid stage in the earth's history—a view favored by many geologists. Proceeding from this stage, Jeffreys deduces the later thermal history. Heat was dissipated by convection and radiation, and solidification occurred in comparatively brief time, starting at the center and progressing outward. After the solid state was reached, further cooling by conduction was extremely slow, and up to the present there has been essentially no lowering of temperatures below a depth of 700 kilometers. Nevertheless cooling in the outer shell has had profound effects. Assuming certain initial temperatures, Jeffreys attempts to show that thermal contraction has been sufficient to produce all known mountain structures.

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[1] Harold Jeffreys: The Earth: Its Origin, History and Physical Constitution. Cambridge University Press, 1924.

This serious revival of the thermal contraction theory has been surprising to geologists, as the conclusions of Osmond Fisher caused general abandonment of this theory many years ago. Jeffreys points out the fallacy in Fisher's reasoning and submits quantitative calculations that are impressive but not wholly convincing, as the values taken for shortening in mountain zones are much too small. In a later paper [2] Jeffreys recognizes this deficiency but suggests that his original estimate for total crumpling by contraction may be increased considerably on certain plausible assumptions. It is possible, therefore, that thermal contraction has been responsible for at least a large part of mountain folding.

The continents are granitic and stand well above the level of ocean basins, which are floored with heavier rock. On the basis of the average content of radioactive minerals in continental rocks, Jeffreys estimates that the thickness of the granitic layer is approximately sixteen kilometers.[3] A comparable thickness is indicated by seismological data. The suggestion is obvious, therefore, that the continents are comparatively thin plates resting upon a substratum of more basic material. But how shall we account for the limited area and peculiar distribution of the continents? It would seem that materials of low density segregated from a molten earth should form a nearly uniform layer over the entire surface. Actually, the granitic plates occupy only one-third the surface area and are for the most part confined to one hemisphere. Both of these facts present serious difficulties under any hypothesis of earth origin. Jeffreys offers suggestions but evidently without conviction, as he states in his last paper "There is at present no explanation of the origin of continents that can be regarded as even remotely satisfactory."[4]

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[2] *Idem:* The Earth's Thermal History, and Some Related Problems, *Geol. Mag.*, Vol. 63, 1926, pp. 516–525.

[3] Holmes and Lawson discovered recently that the radioactivity of potassium is appreciable (Arthur Holmes and R. W. Lawson: Potassium and the Heat of the Earth, *Nature*, No. 2948, Vol. 117, 1926, May 1, pp. 620–621). In view of this discovery, Jeffreys now thinks that his estimate of sixteen kilometers is too large (The Earth's Thermal History, p. 518). A reëxamination of seismological data leads him to suggest that the granitic layer averages 12 kilometers in thickness and that the underlying basaltic layer is 25 kilometers thick (Harold Jeffreys: On Near Earthquakes, *Monthly Notices, Royal Astronom. Soc., Geophys. Suppl.*, Vol. 1, 1926, pp. 385–402.

[4] *Idem:* The Earth's Thermal History, p. 522.

Geodetic data show beyond question that surface inequalities, such as mountain systems, are compensated by differences in average density within a comparatively thin shell. Jeffreys conceives that adjustment for shift of surface load occurs by flowage in a zone of small or zero strength. The strong crust above this zone is much thicker than the granitic layer alone and not identical with it as was assumed by Airy. However, Jeffreys considers that Airy's "roots of mountains" theory is preferable, on geologic grounds, to the Pratt assumption of uniform distribution of compensation to a constant depth.[5] Present geodetic data cannot distinguish satisfactorily between the two forms of compensation, and Bowie's criticism of Airy's theory does not appear to be justified.[6]

Some German scientists have studied the question of isostasy with great care. Otto Meiszner, a student of the master Helmert, points out that geodesists generally favor the Pratt conception of compensation, whereas most geologists prefer Airy's idea of a light crust with variable thickness.[7] In Meiszner's opinion, the Pratt hypothesis has more in its favor than mere convenience of computation; but he concedes that the Airy conception is supported by seismologic evidence. Isostasy is an established principle, but the nature of density distribution remains to be determined by accumulation and study of more data.

T. C. Chamberlin is impressed with the evidence of elastic solidity in the earth, and he proposes that we describe the balancing between earth segments as *elasticostatic* or *elastatic* instead of isostatic.[8] It is evident that his criticism goes deeper than mere terminology and involves a fundamental difference in point of view. In support of his contention he cites the response of the earth to tidal forces and to seismic shocks, the nature of nutation, and the implication of the major geologic processes. He does not discuss the data from geodesy bearing on the compensation for topography by differences in density.

JOLY'S CONTRIBUTION

Jeffreys' book gives an impression of soundness and care, thereby inspiring confidence in his conclusions. However, much of his argument concerning conditions in the outer earth rests on the assumption of continuous cooling—except in pockets of magma generated locally—since the original solidification. Joly has raised serious doubt as to the truth of this assumption. In his recent book, "The Surface-History of the Earth,"[9] he tries to show that heat accumulating from radioactive disintegration in the rocks must cause periodic fusion in a universal subcrust. The reasoning is quite plausible and is backed by quantitative computations. Granitic rocks at the surface have a certain average content of uranium and thorium. Basaltic rocks also contain these elements but in smaller amounts. Uranium and thorium break down at a known rate, developing a supply of heat that would be easily calculable if we knew the distribution of the radioactive elements in depth. Geophysicists are agreed that these elements are confined to a surficial layer of moderate thickness, as their distribution to great depths would result in permanent fusion. Joly believes that the best data from seismology and geodesy indicate a thickness of about thirty kilometers for the continental plates. Assuming uniform distribution of radioactive elements throughout these granitic masses, he computes that the heat generated by disintegration is almost identical with the heat escaping at the surface, as determined from the geothermal gradient and the conductivity of rocks.

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[5] *Idem*: On the Nature of Isostasy, *Gerlands Beiträge zur Geophysik*, Vol. 15, 1926, pp. 167–188.

[6] William Bowie: A Gravimetric Test of the "Roots of Mountains" Theory, *U. S. Coast and Geodetic Survey Serial No. 291*, 1924.

[7] Otto Meiszner: Zur Isostasiefrage, *Petermanns Mitt.*, Vol. 72, 1926, pp. 262–263.

[8] T. C. Chamberlin: Intrageology—Elastasy vs. Isostasy, *Journ. of Geol.*, Vol. 35, 1927, pp. 89–94.

[9] John Joly: The Surface-History of the Earth. Oxford University Press, 1925.

But the plateau basalts, which presumably arose from the basic stratum beneath the continents, also contain measurable amounts of the radioactive elements. Joly reasons, therefore, that heat accumulates in the substratum until widespread melting occurs. With fusion the density of the basic layer decreases, and consequently the continental plates sink to a lower level, permitting seas to flood the lowlands. Under the oceans fusion of the subcrust begins at greater depth than under the continents; but, once it starts, melting proceeds upward until the suboceanic crust is thin enough to permit escape of the surplus heat into the oceanic water. While the entire substratum is liquefied the solid crust, retarded by the tidal brake, slips slowly over the rotating interior; and therefore in time the cooling effect of the oceans is enjoyed by all parts of the liquid layer. Eventually the surplus heat is dissipated, and as the substratum solidifies its density increases to normal, forcing the floating continents upward to their former level.

Under this bold and picturesque hypothesis, therefore, the world-wide emergences of geologic history, succeeding epochs of general submergence, would occur as a logical consequence of isostatic principles. The hypothesis also accounts for other major geologic events. Expansion of the melting substratum would develop tension throughout the lithosphere, and rifting on a large scale would occur. Basic magma would rise to fill the fissures, and in favorable localities the magma would be forced to the surface in large quantities. Contraction of the subcrust on universal cooling would necessitate collapse of the enlarged outer shell, with consequent wrinkling and thrusting. Repetitions of the melting in widely separated geologic periods would explain the cyclic recurrence of diastrophism and major igneous activity. Considered qualitatively, therefore, the hypothesis is very successful from the geologic standpoint.

Reactions to the Joly Hypothesis

Joly's views, in their essential aspect, have a staunch supporter in Holmes, whose ideas on the subject are outlined in a recent paper.[10] He seeks to supplement Joly's presentation, which he finds "too simple to match the complex details of geologic history." His own discovery, with Lawson, that potassium has important radioactive properties suggests that the average thickness of continents is not over fifteen kilometers—an estimate in close accord with that of Jeffreys. But the substratum, in order to buoy up these thin continents to their present height, must be considerably denser than ordinary basalt; and therefore it is assumed, with Fermor, that the rock of the subcrust exists as eclogite, with average density near 3.5. This layer would behave essentially as postulated by Joly, causing cyclic disturbances of the lithosphere. However, geologic history records a few crustal revolutions of unusual severity and complexity, separated by several milder disturbances. To account for these facts Holmes postulates that the eclogite layer lies above a thick zone of peridotite, which has a high melting point and a low content of radioactive materials. Independent cycles of the eclogite layer affect the lithosphere moderately; but, occasionally, coincident fusion of this layer and the peridotite below, with complicated interactions, brings on a period of profound diastrophism, such as that of the late Paleozoic or the Tertiary.

One point in the original Joly-Holmes theory has met a very proper criticism.[11] On the assumption that the ocean waters rest directly on rock typical of the substratum, a condition of instability would exist after fusion began, as the heavy ocean floors would lie above magma of smaller density. It seems inevitable, therefore, that the floors would founder and that the heat of the fused basalt would be given up quickly to the ocean water, with disastrous results both to marine life and to the completion of the Joly cycle. Holmes admits the force of this criticism but attempts to avoid it by postulating a syenite layer, four to eight kilometers thick, between the ocean water and the basic substratum. Recent seismological data lend some support to this assumption. From the geological viewpoint, inclusion of granitic fragments in volcanic rocks on Ascension Island,[12] in mid-Atlantic, may be considered favorable evidence. No such evidence has been reported from the many basaltic islands of the Pacific.

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[10] Arthur Holmes: Contributions to the Theory of Magmatic Cycles, *Geol. Mag.*, Vol. 63, 1926, pp. 306–329.

[11] G. R. MacCarthy: Radioactivity and the Floor of the Oceans, *Geol. Mag.*, Vol. 63, 1926, pp. 301–305.

[12] R. A. Daly: The Geology of Ascension Island, *Proc. Amer. Acad. of Arts and Sci.*, Vol. 60, 1925, pp. 1–80; reference on pp. 63–68.

Jeffreys seems favorably disposed toward the suggestion of a suboceanic syenite layer, but he pronounces Joly's hypothesis of oscillating temperatures out of harmony with physical laws.[13] Joly insists that the heat developed by uranium and thorium makes periodic fusion inevitable. Evans has suggested, however, that a considerable part of the energy liberated by these elements in the rocks "is used up in effecting physical, chemical, and atomic changes in the surrounding minerals."[14] Such changes are indicated by the development of pleochroic haloes around radioactive minerals. This suggestion invites study, but until Evans' criticism is made more tangible it is in no way fatal to the theory of periodic fusion.

Hypothesis of Continental Displacement

Jeffreys admits the possibility that the lithosphere as a whole may lag in rotation,[15] and Joly makes this sort of displacement an essential part of his hypothesis. Taylor and Wegener postulate differential horizontal movements within the lithosphere itself. This radical conception has seized on the fancy of scientists with the fascination of a new toy. Wegener's book has gone through three editions and is now available in an excellent English translation.[16] The author admits frankly that his idea originated in the apparent coincidence of coast lines on opposite sides of the southern Atlantic. The correspondence is truly remarkable but does not in itself constitute any proof that South America and Africa were once adjacent. Wegener seeks evidence in geologic history and in a comparative study of geologic features on opposite sides of the "rift." Certain faunal and floral relationships in the Mesozoic and Paleozoic eras appear to support his view, and present geologic "controls," as interpreted by Wegener himself, make the postulated displacement almost a certainty. Critical study throws considerable doubt on the evidence. On the basis of Wegener's hypothesis we should expect the older faunas on opposite sides of the Atlantic, in areas formerly contiguous, to be nearly identical; but paleontologists find only a small percentage of closely related forms. Although the theory appears to solve some problems of paleogeography it also creates additional difficulties.[17] The physical "controls" match less accurately than Wegener would have us believe.

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[13] Jeffreys, The Earth's Thermal History, pp. 520–522.

[14] J. W. Evans: Regions of Compression, *Quart. Journ. Geol. Soc.*, Vol. 82, 1926, pp. lx–cii; reference on p. lxi. See also the reply by R. W. Lawson: Radioactivity and the Heat of the Earth, *Nature*, Vol. 119, 1927, pp. 277–278, and continuation of correspondence, pp. 424–425 and 703–704.

[15] Jeffreys, The Earth, p. 266.

[16] Alfred Wegener: The Origin of Continents and Oceans. Translated from the third German edition by J. G. A. Skerl. Methuen & Co., London, 1924.

The second German edition of Wegener's book was reviewed by Harry Fielding Reid in the *Geogr. Rev.*, Vol. 12, 1922, pp. 672–674.

[17] See for instance L. Joleaud: L'histoire biogéographique de l'Amérique et la théorie de Wegener, *Journ. Soc. des Américanistes de Paris*, Vol. 16, 1924, pp. 325–360; *idem:* Essai sur l'évolution des milieux géophysiques et biogéographiques, *Bull., Soc. Géol. de France*, Vol. 23, 1924, pp. 205–270.

If South America is placed in its assumed former position beside Africa, the Cape Mountains and the Sierras of Argentina do not correspond either in position or in trend. H. S. Washington, reviewing the evidence from petrology along the whole Atlantic border, finds dissimilarities much more striking than the apparent relationships.[18] It is well known that the Hercynian Mountains of Europe represent an older epoch of orogeny than the Appalachians, and therefore the two systems cannot represent a disrupted unit as suggested by Wegener.

Wegener's hypothesis is not strengthened by geophysical considerations, as no known force appears to be nearly adequate to urge the "sial" plates through the "sima." Assumption that length of time compensates for weakness of the forces is not satisfactory, as the "sima" assuredly has high strength to considerable depth beneath the oceans and therefore cannot act as a viscous fluid. Even if we should grant Wegener this point we could not at the same time accept his explanation that mountains are due to resistance encountered by the forward edge of a moving continent, as a substance devoid of strength cannot be expected to develop powerful resistance. Jeffreys tests the hypothesis by a quantitative comparison of forces.[19] The agencies charged with continental movements can exert stresses equal to 10^{-5} dynes per sq. cm.; to elevate the Rocky Mountains, these stresses would have to be multiplied by 100,000,000,000,000. This test cannot be accepted at full value, as Jeffreys has adopted the erroneous assumption that the Rockies were carried to their present height during the time of folding and thrusting. However, deformation of the strong continental rocks to produce mountain structures required powerful forces and could not have been accomplished by puny secular stresses as an incident in displacing enormous continental masses.

Daly, recognizing the requirement of energy to perform the work of transporting continents and folding mountains, has proposed a modification of the displacement hypothesis.[20] He postulates low domes of continental scale, formed slowly in response to internal contraction, to changes in the rate of rotation, and to the effects of secular erosion. Finally the doming creates a condition of instability in the lithosphere, and continental masses slide down the low gradient, moving over a substratum of hot basaltic glass. Weak sediments in geosynclinal basins near the base of the dome are crushed and thickened by the sliding continents. Later expansion of material driven down into the hot substratum causes uplift of the folded sediments into mountains. Daly's hypothesis has the merit that it recognizes ordinary mechanical principles and makes use of older helpful conceptions, such as contraction of the earth's interior. Wegener rejects all older ideas of diastrophism as obsolete tools.

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[18] H. S. Washington: Comagmatic Regions and the Wegener Hypothesis, *Journ. Washington Acad. of Sci.*, Vol. 13, 1923, pp. 339–347.

[19] Jeffreys, The Earth, p. 261.

[20] R. A. Daly: Our Mobile Earth. Charles Scribner's Sons, New York, 1926.

The final verdict on all forms of the displacement hypothesis must rest on detailed geological study of critical areas. Eastern South America and western Africa must be examined thoroughly for decisive data. If geologists become convinced, on the basis of future discoveries, that these two continents actually have moved apart, no doubt the geophysicists will take a more active interest in the problem.

Deformation by Rotation

Andrews points out that mountain systems are broad, wave-like protuberances above the general level and that corresponding shallow basins extend roughly parallel to them. He advances the hypothesis that these major inequalities result from slow rock flowage induced by rotation.[21] Waves tend to grow in height; but under the influence of gravity the material spreads out, with the production of thrusts and folds. Thus the hypothesis of mountain making by vertical uplift, repeatedly championed by Bowie,[22] is thought to be consistent with the observed facts of great thrusts.

In order to picture the effect of rotation, Andrews imagines three globes, comparable to the earth in size; one made of steel bands, one of closely fitting sand grains with varying composition, the third of closely fitting rocks differing in chemical composition, form, and strength. These globes are set spinning on axes. In the first, a tendency to flow at depths of a few miles will be checked by the strength of the overlying steel. In the sand globe the strong reactions toward the surface will encounter only the resistance of gravity, and large waves will result, with local melting at depth on relief of pressure. The third globe will behave in similar fashion, but resulting surface forms will be more irregular. The argument is very general, with no quantitative checks; and the conclusions are not convincing. A quantitative treatment is promised for the future.

Andrews believes "that the laws of mountain-building admit of extremely simple statement." It is not obvious, however, that the known orogenic features of the earth bear a simple relation to the forces assumed in the hypothesis. Meridional undulations due primarily to rotation should be conspicuously stronger in the equatorial belt than in middle latitudes and should become insignificant in moderately high latitudes. The American Cordilleras do not meet this expectation. Equatorial Africa is almost featureless in comparison with Alaska and Antarctica. Some of the most intense deformation by thrusting and folding is found between parallels 50 and 80 north. There is no apparent reason, under the hypothesis, for the pronounced east-west trends of Eurasian systems in contrast with the north-south trends of American mountains.

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[21] E. C. Andrews: Hypothesis of Mountain-Building, *Bull. Geol. Soc. of America*, Vol. 37, 1926, pp. 439–454.

[22] William Bowie: Geology from the Isostatic Viewpoint, *Scientific Monthly*, Vol. 22, 1926, pp. 5–18.

Idem: Proposed Theory, in Harmony with Isostasy, to Account for Major Changes in the Elevation of the Earth's Surface, *Gerlands Beiträge zur Geophysik*, Vol. 15, 1926, pp. 103–115.

Idem: The Part Played by Isostasy in Geophysics and Geology, *Journ. Washington Acad. of Sci.*, Vol. 17, 1927, pp. 101–117.

General Comment

From consideration of these diverse conceptions the ultimate cause of diastrophism is seen to be as much as ever the great mystery of geology and a major problem of geophysics. It may even appear, from Jeffreys' revival of the thermal contraction theory, that efforts to learn the secret are moving in a circle. However, it is not fair to conclude that the problem is altogether insoluble or that the various speculative views are without value. Progress in study of the inner earth has been most gratifying, and the large number of recent theoretical discussions may be taken as first attempts to capitalize the new knowledge. Painstaking inductive study must continue to furnish the essential data; but judicious speculation and theory have their place in lending zest to endeavor and in actually guiding attack on critical problems.

The methods of seismology and geodesy may be expected to provide the most significant data for further study of the earth's interior. Experimental work in geophysical laboratories will throw additional light on the behavior of rocks under high pressure and temperatures. Needless to say, the evidence of diastrophism obtainable on the surface of the earth is still woefully incomplete and will remain so until wide regions have been studied and mapped geologically.

THE LOST GLOBE GORES OF JOHANN SCHÖNER, 1523-1524: A REVIEW*

George E. Nunn

THE first volume of Dr. Wieder's "Monumenta Cartographica" contains a reproduction of what is declared to be Johann Schöner's lost globe of 1523-1524. This globe belongs to a most important period of discovery and exploration. It was based in part on information derived from the Magellan voyage. It is an extremely significant link in the cartographical record of the most productive period in geographical history. The globe has been known hitherto only from the letter of Schöner to von Streytpergk and from the partial description in Schöner's "Opusculum Geographicum."[1] In the Streytpergk letter Schöner denies the intention of setting aside one of his earlier globes. Instead he maintains that, so far as it goes, the earlier globe agrees with the later one. The "Opusculum Geographicum" contains some information concerning Schöner's ideas of American-Asiatic geography with which the globe of 1523-1524 should conform.

CRITERIA FOR IDENTIFICATION

Henry Stevens of Vermont thought that he had identified the globe with the Rosenthal gores. Nordenskiöld and others, however, have not accepted these gores as the real Schöner globe. The evidence on the Stevens' Schöner may be summarized: affirmatively, it is a gore map showing the track of the Magellan expedition and belonging undoubtedly to a time not long after Magellan; negatively, there is a separation of the Americas from Asia by a long narrow strait debouching into the Atlantic north of Bacalaos, and the map does not contain the names in Schöner's "Opusculum Geographicum," wherein the American geography is completely merged with the Asiatic. Nordenskiöld thought that the Stevens map belonged to a period about 1540.[2] However, as Heawood[3] points out, it has since been shown by Miss Mary Hervey that Holbein used this map in a painting in the year 1533.

Dr. Wieder's map contains the American-Asiatic geography in conformity with the "Opusculum Geographicum." South America is made a peninsula of the Asiatic continent. Temistitan, or Mexico City, is identified with the Quinsay of Marco Polo and is situated on a lake. The city is placed approximately in longitude 226° E. and latitude 21° N. in conformity with the "Opusculum Geographicum."[4] The names Mangi, Cathay, and Asia are located side by side with Messigo, Parias, and Urabe. With two or three exceptions all of the names mentioned in Schöner's book are found on this map and in such an order that there is in every case a geographical propinquity between the successive names. The only changes needed to secure complete conformity are the reading of east for west where Schöner mentions Parias,

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* A review of F. C. Wieder, edit.: Monumenta Cartographica: Reproductions of unique and rare maps, plans and views in the actual size of the originals; accompanied by cartographical monographs. Vol. I, The Hague, 1925.

[1] Henry Harrisse: The Discovery of North America, London and Paris, 1892, pp. 524-525.

[2] A. E. Nordenskiöld: Facsimile Atlas to the Early History of Cartography, Stockholm, 1889, pp. 80 and 82 and Pl. XL.

[3] Edward Heawood: The World Map Before and After Magellan's Voyage, *Geogr. Journ.*, Vol. 57, 1921, pp. 431-446; reference on p. 441.

[4] Harrisse, *op. cit.*, p. 524.

Darien, and Urabe, and the alteration of the latitude of the city of Lop from 43 degrees to 48 degrees.

Finally the name "Perisch," at the bottom of the right gore on Plate 3, seems a decisive piece of evidence. As Dr. Wieder points out, this name does not occur on any other known map. Dr. Wieder interprets it as "Per J. Sch."—that is, by Johann Schöner. The present writer is ready to accept Dr. Wieder's identification of this map as the real Schöner globe of 1523–1524.

The Behaim Conceptions

This Schöner gore map is the first of a type that was common in the second quarter of the sixteenth century. The essential features are derived from the Behaim combination of the Ptolemaic world map and the narrative of Marco Polo. This original concept was modified by nearly thirty years of discovery and exploration on the part of the Spaniards, Portuguese, and English. The evolution of the Schöner 1523 type of map may be summarized as follows. In the latter years of the fifteenth century Ptolemy's "Geography" had become the geographical Bible to the peoples of western Europe. Ptolemy had mapped the world from the Canary Islands eastward to the eastern shore of the Magnus Sinus. This known portion of the world was comprised within 180 degrees. In his extreme east Ptolemy placed Serica, the Sinarum Situs, and the emporium of Cattigara. His information was misinterpreted so that the coast of China, which should have been represented as part of the coast of eastern Asia, was falsely made to represent an eastern shore of the Indian Ocean. As a result Ptolemy implied more land east of the 180th meridian and an ocean beyond. Marco Polo's account of his travels in eastern Asia described lands and seaports on an eastern ocean apparently unknown to Ptolemy.

Contrary to the ideas of Vignaud and Rosenstein there was a plausible interpretation of Marco Polo's narrative which authorized the extensive additions of the Behaim globe to the Ptolemaic map. The fact that Ptolemy did not represent an eastern coast of Asia made it admissible for Behaim to extend that continent far to the east. Marco Polo relates his travels westward from Cambaluc for 132 days. At the end of this journey he said that he was *very near India.* In interpreting this account, allowing 20 miles a day for the average rate of travel and 50 miles for a degree of longitude near the 40th parallel, Marco Polo's journey represents a distance of 53 degrees. Behaim's globe placed Polo's Mangi and Cathay east of Ptolemy's 180th meridian and Cambaluc on the 41st parallel, approximately in longitude 233 degrees E.[5] Behaim allowed 60 degrees beyond Ptolemy's 180 degrees for the mainland of Asia and 30 degrees more to the east coast of Cipangu. Cipangu and the mainland of Asia were thus placed only 90 and 120 degrees, respectively, west of the Canary Islands. Marco Polo placed the kingdom of Prester John west of Cathay and Mangi; Marino Sanuto, Nicolo Conti, and Jordanus placed it in the interior of India Tertia, or that part of Asia beyond the Ganges River equivalent to the Serica of Ptolemy. Marco Polo also described the lands between Kenjanfu and Tibet as having an abundance of silk. These regions west of Mangi were considered by Behaim as equivalent to Ptolemy's Sinarum Situs, with which the Romans traded by sea for silks.

Effect of the Columbian Discoveries

Columbus reintroduced two old factors into this geography by using 56⅔ Italian nautical miles as the length of a degree instead of the longer degree of Ptolemy and by adopting Marinus of Tyre's longitude of 225 degrees for the east coast of the

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[5] Similar geographical conceptions are represented by the Laon globe and by the map of Henricus Martellus Germanus, both probably dating from the period before the discovery of America.

Magnus Sinus. This resulted in a considerable eastward advancement of the longitudes given by Columbus' contemporaries—such as Behaim. By some process Columbus reasoned that the longitudes of eastern Asia and Cipangu respectively were about 270 and 300 degrees east, or 90 and 60 degrees west of the Canary Islands. Columbus stated that he had sailed 1100 leagues from the Canaries when he found Cuba. This was approximately where he thought the coast of eastern Asia would be found. On this basis of calculation he identified Española with Cipangu, which he had expected to find on the outward voyage at a distance of about 700 leagues from the Canaries.

The later voyages of Columbus resulted in further exploration of Cuba and in the discovery of South and Central America. At first South America was considered a great island of continental proportions; but as a result of Columbus' fourth voyage, it was apparently considered to be identical with the great southeastern peninsula of Asia represented by Behaim. This seems to be the best interpretation of the Bartholomew Columbus map of about 1506, when considered in connection with some Portuguese letters stating that St. Thomas[6] had been among the Indians of the east coast of South America. There is a legend on this Bartholomew Columbus map concerning the different longitudes of Ptolemy on the one part and Columbus on the other. In accord with this legend the map employs the longitudes of Ptolemy from the Canary Islands *east* to the Magnus Sinus. A different longitude calculation is employed for the space between the Canary Islands *west* to the same point. There are thirteen spaces marked, each space apparently having 10 degrees; but there are no figures to show their extent. This difference in the calculation of longitudes is an extremely important matter for the understanding of the explorations of the early sixteenth century, and it has not hitherto been given adequate consideration.

Waldseemüller and Cantino and Canerio Maps

There are two other types of maps that have introduced many errors into the interpretation of Columbian geography. These maps are derived from the Waldseemüller map of 1507 and from the Cantino and Canerio maps of about 1502. The Waldseemüller map represents the Behaim conception of the earth as far as longitude 270° E. and terminates in the east with an open sea. On the left side of the map the Spanish discoveries are represented as a long narrow strip of land extending from about latitude 50° N. to latitude 40° S. The western side of the land is named in the south "Terra Ultra Incognita" and in the north "Terra Ulteri Incognita." There is a conjectural sea to the west of the land. The difference in longitude between the eastern coast of Asia on the Behaim globe and the Columbian mainland of "Florida" on the Waldseemüller map is 55 degrees. On other maps of the type the difference is only 45 degrees. This type of map *apparently* makes the Americas a distinct continent by representing Asia as complete and by neither indicating nor implying that it has any connection with America. Schöner's globe of 1520 belongs to this Waldseemüller type. Every other type of map made before 1550 actually makes or implies a connection between America and Asia.

The Cantino-Canerio type of map discards Ptolemy's outline of eastern Asia and likewise represents considerably less than the full circumference of the earth. On the right, or eastern, margin the map terminates just east of the Malacca peninsula. However, the coast line does not round off to the north and west to complete the Asiatic continent but bends sharply into the edge of the map as if there were more land to the east. On the left, or western and Spanish, side the map is cut off immediately west of a peninsula that resembles Florida. The names on this land definitely prove it to be Cuba, identified by Columbus as a part of Asia. Other maps of the type contain in connection with this peninsula the legend, "Terra de Cuba Asie Partis." Furthermore, another legend in the region of the Corte-Real discoveries definitely calls the land a part of Asia. From this it is evident that the Portuguese map makers did not question the Asiatic character of the Columbian discoveries at the time when these maps were made.

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[6] Bartholomew de Las Casas: Historia de las Indias (5 vols., Madrid, 1875–76), Vol. 2, p. 465.

Relation Between Asia and America

From the above it becomes apparent that the present accepted view, namely that it was early understood that America was distinct from Asia, needs revision. A new hypothesis is required, one that neither (1) envisages two separate and distinct continents, since such continents are not represented on any other type of maps, (2) nor admits of two east coasts of Asia, (3) nor removes from the map Behaim's enormous eastern Asia prior to any exploration of the region in which it was placed, (4) nor leaves unaccounted for otherwise the important island of Cipangu. Such an hypothesis, suggested by the legend concerning longitudes found on the Bartholomew Columbus map, may be stated as follows: the various map types represent, each in its own way exactly the same general conception of world geography.

This conception was that of the world as shown on the Behaim globe, the persistence of which is evident to anyone who will assemble the maps remaining to us from the early sixteenth century. *Apparent* differences between the several types of map were due to differences in conception regarding the length of a degree. The Waldseemüller maps solved the problem by merely duplicating the eastern coast of Asia. On the right side Asia was represented with the Ptolemy-Behaim longitudes; on the left it was given with Columbian longitudes. Two theories were thus presented on one map, and you could take your choice between them. This was a very plausible way of presenting a problem at the time insoluble.

The Cantino-Canerio maps do not deny the Ptolemy-Behaim geography. They imply it but avoid the longitude question by leaving off all indication of longitude. To admit that these maps discard Behaim's eastern Asia would be to violate what we may here state as an axiom, "Any feature once placed on a map tends to remain until complete exploration leaves no room for it." According to my hypothesis, therefore, the Spanish lands represented on the left side of the Cantino and Canerio maps are no other than Behaim's extreme east of Asia, and the Island of Cipangu is represented by Española, with which it was identified by Columbus and upon the Johan Ruysch map. The Waldseemüller type on the other hand *duplicates* both eastern Asia and Cipangu. This view of the Asiatic connection of the Spanish discoveries would appear to be further confirmed by the Portuguese letters about St. Thomas having been among the Indians on the eastern coast of South America, by the names on "Florida" and the legend about Asia on the Cantino and Canerio maps, and by the three Reinel charts of the East Indies,—the first and second of which show an eastern coast of the Magnus Sinus. The Magnus Sinus itself is named on some of the maps as the Mar del Sur. On the Wieder-Schöner it is the Mar de Sur. Moreover, it is known that Balboa expected to find the Spice Islands not far west of the Isthmus of Panama. Cortes also looked for the Spice Islands off the coast of Mexico.

The Schöner Map

This brings us to the Schöner map of 1523–1524. Magellan's voyage of 1519–1521 is said to have proved that South America, by some regarded as an island (witness the Lenox globe and the Schöner globe of 1520), was a part of Asia. No one, of course, could reach this conclusion except theoretically and on the basis of a particular hypothesis. All of the known world maps dating back to the period between 1492 and 1520 either actually represent, imply, or, at least, do not deny the existence of the eastern Asia of Behaim. Some of them, as the Waldseemüller map of 1507, represent two eastern Asias and either two peninsulas from southeastern Asia or one peninsula and one great island. One peninsula at least was assumed as indisputable. The Spaniards had quite definitely proved by 1523 that South America was connected with the northern continent. Magellan showed by his voyage that only one great peninsula besides Africa extends into the southern hemisphere. Therefore, under the assumption mentioned, South America was demonstrated to be a part of Asia and, *ipso facto*, to be the Behaim peninsula of southeastern Asia. It is particularly significant that Schöner should have said that his two globes agree with each other—unless we are to believe that the Spanish lands, represented as separated from Asia on the 1520 globe, were somehow regarded as a duplication of eastern Asia.

After 1523, with few exceptions, the maps belong either, on the one hand, to the type of the Ribero school, having unexplored coasts omitted but not denying the Asiatic connection of America, or, on the other hand, to the general type of the Wieder-Schöner map. In both types the duplication of eastern Asia ceases and the Behaim peninsula disappears—unless the South American continent is intended for it. The Mar del Sur is identical with a greatly enlarged Magnus Sinus. The town of Cattigara was repeatedly placed on the west coast of South America, and this may have had some influence in leading Pizarro to Peru.

The Wieder-Schöner gore map, if genuine, is the oldest map remaining to us, except the Bartholomew Columbus map, that definitely and simply represents the world according to the later Columbian conception of the configuration of the land. It was able to do this more clearly than any predecessor because Magellan's voyage made it impossible for anybody plausibly to contend for Columbus' short degree. The elimination of the Columbian degree permitted a reasonable harmony of opinion on the subject of longitudes. As a result, for a considerable period of years, the Schöner map of 1523 became the prevailing type. The one important exception is a group of French maps resulting from the Verrazano discoveries. The next important change in the cartographical outline of America-Asia was due to the introduction of the Strait of Anian, and that was based on the fact that the American continents nowhere contained the fauna of Asia.

Dr. Wieder's Work

Dr. Wieder's work gives promise of being a really noteworthy contribution to historical geography. In addition to the gores described above, the present volume contains "Central Europe by N. B. 1553" (Natalis Bonifacius); "The Straits of Magellan by Thomas Cavendish, 1588"; "C(ornelis) D(oetsz) Navigation chart to the North and the Baltic, 1610 issue of the unknown original edition of 1589"; "The Philippines Islands, c. 1660"; together with 18 plates and plans of cities and ports taken from the manuscript atlas of Johannes Vingboons dating about 1660. The notes and bibliographical references add markedly to the value of the work.

There is only one serious objection to the plan of the first volume. While the views and plans of cities are certainly not without interest to the geographer, one cannot but regret that this material of relatively lesser interest has been included while there remain unreproduced and very difficult of access many map treasures of greater and more general importance. It is to be hoped that the future volumes will be devoted to maps alone until all of the rare old maps of the libraries of Germany and Holland have been made readily available. A contemporary work, "Tabulae Geographicae Vetustiores in Italia Adservatae," by G. Curaci, proposes to reproduce the rare maps now contained in the libraries of Italy.[7] Would that capable cartographical authorities might soon attempt a similar task for England, France, and Spain.

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[7] Reviewed in the *Geogr. Rev.*, Vol. 17, 1927, pp. 174–175.

AMERICAN GEOGRAPHICAL SOCIETY

Meetings of March and April. At the regular monthly meeting of the Society on March 22, President John H. Finley presiding, Sir Curtis Lampson described his journey across the French Sudan to Timbuktu. From many remote districts he was able to gather an excellent photographic record and valuable notes on Tuareg customs, native industries, and desert and oasis scenery.

At the regular monthly meeting of the Society on April 26, President John H. Finley presiding, Dr. Samuel K. Lothrop of the Museum of the American Indian delivered a lecture entitled "Aboriginal American Culture and the Geographical Environment." He described the cultural similarities and differences of aboriginal groups in North and South America, illustrating his address with photographs of some of the best specimens in the Museum. In addition he outlined the results of original field work upon the sites of some of the newest and most interesting archeological discoveries of recent years.

Before the lecture President Finley read Council resolutions on the death of Dr. Walter B. James and Mr. Edwin Swift Balch. He commented on their long association with the governing body of the Society and their part in forwarding its research work. The resolutions are printed below.

Elections to Fellowship. At the March and April meetings of the Society, President Finley presiding, there were presented with the approval of the Council the names of 41 candidates, who were duly elected as Fellows of the Society.

Resolution on the Death of Dr. Walter B. James. Dr. James died at his home in New York on April 6. The following resolution was passed by the Council at its monthly meeting of April 17 and entered upon the permanent records:

"By the death of Dr. Walter B. James on April 6 the Society has lost an old and valued friend. It is fitting that the Council should record its appreciation of his services and character. He became a Fellow of the Society on March 10, 1890, and, joining the Council on March 17, 1910, continued with the administration until his death. He was Vice President of the Society from February 16, 1911, until December, 1914, when he resigned. He served on many important committees and was active and most helpful in affairs both by his labor and advice. His wide experience, his clarity of judgment, and his scholarly attainments rendered him a most capable associate, and he gave freely of his time and effort notwithstanding widespread demands upon him of public and civic service. His courtesy and consideration for the feelings of others endeared him to his associates and create a sense of personal sorrow in the void left by his departure. We tender to his family our respectful sympathy in their bereavement."

Dr. James had two faculties which were especially appreciated by his associates at the American Geographical Society: he liked to give time and thought to the work of the institution, and he had the gift of hospitality. He was interested in research, for its purposes and needs were clear to him from his experience as an investigator in medical science. The Millionth Map of Hispanic America had his special support and interest, and he watched its progress as closely as he did that of the other publications of the Society. At his hospitable fireside the publication committee, of which he was for many years the chairman, held its annual meeting. Encouragement and practical help were always given in full measure under his wise and tolerant leadership.

Resolution on the Death of Mr. Edwin Swift Balch. Mr. Balch died at his home in Philadelphia on March 15. The following resolution was passed by the Council at its monthly meeting of April 17 and entered upon the permanent records.

"RESOLVED that the Council of the Society express to the family of their late associate, Edwin Swift Balch, their deepest sympathy. Mr. Balch was elected a Life Fellow on November 13, 1900, and he was elected to the Council of the Society on November 21, 1912. He was often consulted on geographical questions, upon which he gave able advice; he published important papers on geographical questions in the journal of the Society; he was active on committees of the Council and attended the meetings of the Council with regularity; and he was in active correspondence with the administrative officers regarding the policy and activities of the Society. He could always be counted upon for the support and encouragement of the Society's work and followed all of its proceedings with the deepest interest."

Mr. Balch's interest lay primarily in exploratory fields, especially mountaineering and polar exploration, his views thereon being expounded in a series of books. He also sought to make geographical application of his studies of the fine arts, publishing several volumes on the distribution of art and its bearing on comparative ethnology. He contributed numerous papers to scientific periodicals: those to the *Bulletin of the American Geographical Society* including: "Stonington Antarctic Explorers" (Vol. 41, 1909), "Heart of the Antarctic" (Vol. 42, 1910), "Charcot's Antarctic Explorations" (Vol. 43, 1911), "Palmer Land" (Vol. 43, 1911), and "Antarctic Names" (Vol. 37, 1905, and Vol. 44, 1912). His last contribution to the Society's journal, "The First Sighting of West Antarctica" (*Geogr. Rev.*, October, 1925, was in continuation of his efforts to promote a knowledge of the important share that Americans, notably Wilkes and Palmer, have had in the exploration of the Antarctic.

Elections to Membership in the Council. At the March meeting of the Council of the Society on April 17, Mr. Oliver B. James and Mr. Frederick Hellmann were elected Councilors of the Class of 1930.

Donations to the photographic collections. Through the kindness and generosity of Mr. Henry J. Thayer the Society has received from time to time a large collection of panoramic photographs from Central and South America, including the gift in May last of 54 views taken in Peru, Chile, Argentina, Uruguay, Brazil, and the Panama Canal. Grateful acknowledgment is hereby made of these valuable contributions to the Society's collections.

GEOGRAPHICAL RECORD

NORTH AMERICA

The Port of New York. In the *Geographical Review* for October, 1925 (Vol. 15, pp. 654–655) announcement was made of the publication by the Corps of Engineers of the U. S. Army and the U. S. Shipping Board of the first five numbers of a series of documents relating to American ports. Since then twelve more numbers of this important "Port Series" have appeared, one of which, No. 20, deals with New York. This number is divided into three parts: Part 1, a general report; Part 2, statistical data relative to piers, wharves, and docks; and Part 3, an atlas of large scale maps showing the various port facilities.

Disregarding the broader relations of New York, let us consider briefly a few significant facts about this great port, which itself constitutes a geographical region of no small area and of enormous complexity. The area included under the jurisdiction of the Port of New York Authority, "an organization formed by compact between the States of New York and New Jersey" and ratified by the U. S. Government in 1921, includes not only the city of New York, but the southern half of Westchester County in New York State, as well as "nearly five whole counties in New Jersey." The population of this area in 1920 was 7,750,000.

Two mighty factors contributing to the growth of New York are the size and the intricate configuration of the body of water which comprises New York harbor and its connecting bays and rivers. These provide not only a vast stretch of sheltered water for anchorage but also an immense water frontage. At the present time no less than forty-nine anchorage grounds are reserved by the administration of the port. A high degree of specialization has been developed in the apportionment of these anchorages. For instance, anchorage No. 7 in the East River is "used mainly by sail vessels and barges, eastbound," No. 15, also in the East River is "largely used by steam yachts." No. 19 on the east side of the Hudson River is reserved for ships of the U. S. Navy; other anchorages are set aside exclusively for steamships, for barges, for sailing vessels, for the temporary use of "large ships waiting for a berth, occupancy not to exceed 72 hours . . . ," and six anchorages are reserved for vessels carrying explosives.

The port of New York has a direct water frontage of 771 miles. "The developed frontage measured around piers and the heads of slips is 346.5 miles." There is thus ample room for further expansion. The local topography, however, creates certain very serious drawbacks. These arise primarily out of the fact that the greater part of the immense population of the port of New York, together with its principal transshipment areas, are on islands separated from the mainland to the west by bodies of water a mile and more wide. The majority of ocean vessels find their berths on the side of the harbor opposite the freight terminals of all but one of the railroads leading to the interior of the country. As a consequence, not only does most of the traffic between the markets and manufactories of Greater New York City and the interior have to be shipped across the water to the New Jersey side, but, in addition, the bulk of the imports and exports that pass through the port. The reasons for this will be found in the historical development of New York, which "as a port antedates railroads. The city knew ships and barges from the beginning of its history, and had taken the outline of its present shape before rail transportation on the modern scale was thought of. Herein it differs from younger ports, as on the Gulf and Pacific coasts, which were shaped by railroads or by the local authorities from the start."

Owing to this topographical peculiarity, the visitor to the port of New York sees innumerable barges and freight-car floats plying back and forth between Manhattan, Brooklyn, and the New Jersey shore. Of a stretch of 13.9 miles of waterfront on the New Jersey side of the Hudson, no less than 7.27 miles are controlled by railroads. "On Manhattan, from the foot of West Seventy-second Street around the Battery to the foot of East Twenty-second Street, a distance of 10.67 miles, 2.55 miles are occupied by railroad lighterage piers, float bridges, and pier stations." Although the costs of the transshipments thus effected are immense, the economies achieved in other ways through the use of New York as a shipping port so far outbalance them that there seems little chance of New York ever losing its supreme position among the ports of America.

A Fossil River in Kansas. A striking and well illustrated account of a fossil river channel in western Kansas is given by W. W. Rubey and N. W. Bass in Bulletin 10 (1925) of the State Geological Survey (The Geology of Russell County, Kansas, with Special Reference to Oil and Gas Resources, pp. 7–86). The rolling surface of the county, worn to moderate or low relief on a series of nearly horizontal sandstones and shales with occasional badland patches along the sides of its larger valleys, is interrupted here and there on its gentle slopes by ragged outcrops or "hoodoos" of cross-bedded sandstones, vivid reddish in color alternating with white, gray, buff, and brown, which appear to be the exposed parts of the channel deposits, elsewhere eroded or buried, of an ancient river that flowed westward, as indicated by the prevailing slant of the cross-bedding, at the time when the associated finer-grained and more evenly bedded strata were laid down probably as flood-plain deposits. The hoodoos are frequently enough exhibited along a serpentine course on the broadly dissected plains to make it probable that, as shown on an outline map, their sandstones are the deposits of a single and continuous meandering stream of good size, with one or two tributaries.

W. M. Davis

Meteorological Conditions along the Chicago-Fort Worth Airway. The rapid development of regular flying routes and the importance of meteorology in relation to flight are both strikingly emphasized in W. R. Gregg's "Meteorological Conditions Along Airways" (*Natl. Advisory Committee for Aeronautics Rept. No. 245*, Washington, 1926).

What aviators need is information concerning the principal meteorological elements as determined by records extending over as many years as possible, and also the current data and forecasts for each airway. Decisions regarding the locations of landing fields, the orientation of airdromes, the adoption of flight schedules, and many other similar matters, require as full and as accurate a knowledge of meteorological conditions and phenomena as can be made available. Such conditions as local wind gustiness due to topography; fogs; the probability of heavy rains or snows or ice storms, and visibility, must be known in advance if the best arrangements for flying routes are to be made. The characteristics of the winds at different levels; the frequency of low clouds; the number and intensity of thunderstorms; the frequency of excessive precipitation, are other conditions of vital importance.

The meteorological conditions along the Chicago-Fort Worth Airway are discussed as an example of what is known and can at once be made available for practical everyday use on the part of aviators. The vital factor of the wind at different elevations is discussed as fully as the available data permit. Several interesting points are brought out. For example, the frequency of very low visibilities is not a serious factor along the route; dense fog is of infrequent occurrence; snow is a serious problem only over the northern third of the route; night thunderstorms are often severe; during hot weather flying takes place at comfortable temperatures at a moderate altitude, and when it is excessively cold at the surface there is but little decrease of temperature with elevation—in fact, it is often warmer aloft; there is a distinct preponderance of westerly and northwesterly winds at the higher levels, especially over the northern part of the airway.

R. DeC. Ward

The Climates of California. By reason of its great latitudinal extent, and its marked topographic features, California necessarily includes a wide range of climates and has therefore always been of peculiar interest to climatologists and geographers. There are available the rather meager official discussions of California's climates in the regular Weather Bureau publications. There is McAdie's "Climatology of California." There are several special reports on the rainfall by McAdie, W. G. Reed, and others. There has also been a brief discussion of the climatic provinces of the state by Reed in his paper on the climatic provinces of the western United States (*Bull. Amer. Geogr. Soc.*, Vol. 47, 1915, pp. 1–19).

In a recent monograph, "Climates of California," by R. J. Russell (*Univ. of California Publs. in Geogr.*, Vol. 2, 1926, pp. 73–84), Köppen's well-known classification of climates is followed in the main, but certain modifications based on local climatological data have been adopted. A few minor changes have been made in the critical values suggested by Köppen, and four new sub-types of climate have been introduced. The distinction between dry (B) and humid (C and D) climates is naturally of special significance in California. With the California maximum of rainfall, the boundary between these two is marked by the isohyetal line of 14 inches when the mean annual temperature approximates 55° F. When, with higher temperature, evaporation increases, there is need of more rainfall. At a mean annual temperature of 70° F., for example, the isohyetal line of approximately 17 inches becomes the boundary. A similar general relationship obtains between the desert and the steppe areas. At a mean annual temperature of 70° F., "desert" areas may have as much as 13 inches of rainfall. Russell finds that a cold-month isotherm is just as applicable as a climatic boundary in dry as in humid climates and has modified Köppen's scheme in that respect, Köppen having used cold-month isotherms as boundaries in the humid areas and mean annual isotherms in dry areas. For example, the January isotherm of 32° F. is used to separate the dry cold from the dry hot. A minor subdivision of the "hot desert" is introduced in order that the Mohave and the Colorado types may be differentiated—a distinction demanded on biological grounds. The author also points out that "double-roofed houses, arcaded sidewalks, and other cultural evidences of hot weather are more common in the Colorado than in the Mohave." The line which separates areas having three months or more of mean maximum temperatures above 100° F. from those below those limits is a satisfactory criterion in the desert areas. The west coast foggy desert of the southernmost coast will probably later need subdivision, in the light of newer data. Köppen's "hot summer" and "cool summer" Mediterranean types are found to fit California conditions very well. The former is typified by the Sacramento Valley; the latter, by the Coast Range region of Central California. A new province embracing the well-known "fog belt," with the Redwoods and California Laurel, is added to Köppen's scheme, as is a province whose lower boundary is marked by the isohyet of .75 inch for the three consecutive driest months, and which includes the yellow pine—Douglas fir forest. There are also certain other modifications for the details of which the reader should consult the original paper. The tundra climate, with monthly means below 50° F., is found in a narrow strip in the High Sierra and on the summit of Mt. Shasta.

An excellent colored map shows the various climatic provinces. This is on a sufficiently large scale to be useful in any local studies of California climates. The report is a noteworthy illustration of the fundamental soundness and usefulness of Köppen's original map and of desirable modifications of that scheme for detailed local study.

R. DeC. Ward

The Indians of Southeastern Panama. Southeastern Panama, the scene of the first Spanish exploration and settlement on continental America, "ethnologically has remained practically unknown." The scant available data are discussed by Mr. H. W. Krieger in a recent publication of the Smithsonian Institution (Material Culture of the People of Southeastern Panama, Based on Specimens in the United States National Museum, *U. S. Natl. Museum Bull. 134*, Washington, 1926). The Indian population belongs to two major stocks, Chocó and Cuna. The Chocó live on the Pacific slope of the major divide formed by the Cordillera de San Blas and the Serrania del Darien. The Cuna occupy the upper Chucunaque basin, the central highlands, and the Caribbean coast, the Cuna of the last-named region forming a distinct tribal group—the Tule (Towali), or San Blas, Indians. From certain sections of the country, notably adjacent to the Canal Zone and in the Tuira valley, the Indian has been forced out by a population mainly negroid, but there remain large areas without permanent inhabitants so far as is known. It is reported that

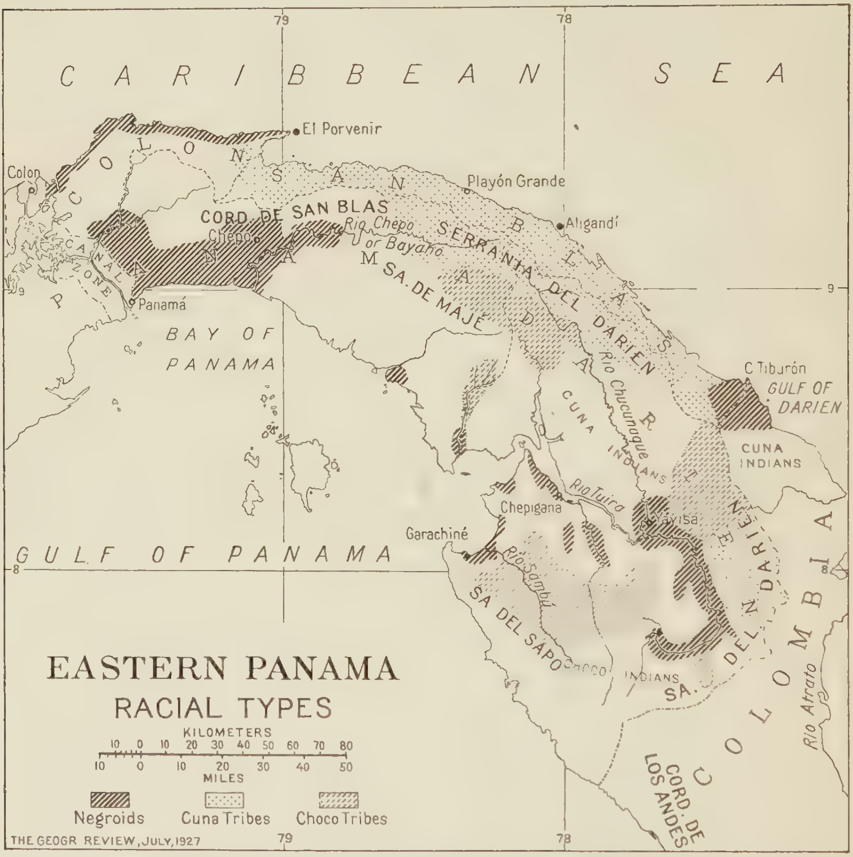

Fig. 1—Map of Panama east of the Canal Zone, showing the distribution of the main racial types. The white areas are supposedly without permanent inhabitants. Based on Figure 1 of Mr. H. W. Krieger's report. The original shows tribal subdivisions among the Cuna. Scale 1 : 3,000,000.

the interior formerly was more extensively and permanently occupied. The middle Chucunaque River now is intermittently traversed by roving bands of mountain Cuna. The swampy and unhealthful area along the Pacific coast is uninhabited, with the exception of some negroid settlements.

Chocó and Cuna exhibit physical and cultural dissimilarities. On the basis of measurements made by Mr. R. O. Marsh's expedition of 1924, Dr. Hrdlička describes the Chocó as being nearer the Nahua type, while the coastal Cuna are related to the Maya on one hand and the Yungas of the Peruvian coast on the other (Aleš Hrdlička: The Indians of Panama, *Amer. Journ. of Phys. Anthropol.*, Vol. 9, 1926, pp. 1–15). A striking difference between the two peoples is seen in their relation with outsiders. The Chocó are trusting and hospitable (cf. Thomas Barbour and W. S. Brooks: The Sapo Mountains and the Sambú Valley, *Geogr. Rev.*, Vol. 13, 1923, pp. 211–222). The Tule, hostile to foreigners, have preserved their tribal isolation in a remarkable way. Culturally, as exemplified in their houses and boats and in their social organization, the Tule are superior. They live in villages on the small islands that fringe the hundred-mile stretch of the San Blas coast. Their plantations are on the mainland, where the men also go to hunt game. Their numbers are estimated by the Intendente of San Blas as between 20,000 and 25,000. In a list of villages compiled by Mr. Marsh the population is given at a little over 24,000. By gaining the confidence of the San Blas Indians his expedition had exceptional opportunities for study. One result of it was to give prominence to the "white Indians" of the region. General scientific opinion, as expressed in the report of Mr. R. G. Harris (The San Blas Indians, *Amer. Journ. of Phys. Anthropol.*, Vol. 9, 1926, pp. 17–63) is that the white Indians represent a form of albinism, a condition that appears to be not infrequent among tropical Indian tribes. The percentage of albinism among the Tule is, however, exceedingly high, 0.7 per cent, and is to be attributed to intense inbreeding in their jealously maintained isolation.

SOUTH AMERICA

Irrigation Projects in Peru. The irrigation canal is a part of the traditional equipment of the Peruvian farmer. Of the 4,000,000 acres estimated to be under cultivation at present in the Cordillera and the coastal valleys of the republic the greater part is irrigated. In the coastal valleys, where 640,000 acres now under cultivation produce nearly half of the agricultural produce of the country, the farmer must depend entirely upon the irrigation canal for his water supply.

There is much evidence of extensive irrigation systems in pre-Inca times. Certainly the strength of the Incas was due in no small degree to the fact that they had insured the well-being of the agricultural population of the empire by organizing them into communities and providing them with highly efficient systems of irrigation and a well-considered plan of land tenure, water rights, and crop rotation. When the Spanish divided the farm lands of the conquered Inca Empire into great estates they destroyed many of the Indian farm communities. Those which they retained in order that they might have an established agricultural population upon which they could draw for labor were kept in quite as complete a state of subservience as they had known under Inca rule with none of its compensating benefices. In the coastal valleys such of the farm communities as were not destroyed were permitted to retain a semblance of their traditional rights to land and water. But the formation of large estates greatly diminished the amount of land available for small holdings; and, except in those places where the water rights of the Indian were protected by the Church, only the surplus water that was left after the full requirements of the estates had been filled was released to them. Moreover, without the regulations for the upkeep of the irrigation canals which the Incas rigorously enforced, much of the old irrigation systems fell gradually into disuse. Under the first seventy-five years of the republic little was attempted and nothing accomplished to improve conditions. Today many of the large estates have no longer sufficient water to keep more than a half or a third of their land under cultivation, and a large part of the land still under cultivation has water only in the flood season. The condition of the small land owners is even worse.

President Leguia at the beginning of his first administration in 1908 recognized the deplorable state into which the rural Indians had fallen as the chief obstacle in the way of social progress in his country. To provide for the economic independence of a farm population which was increasing at an estimated rate of 28,000 a year the large estates might have been divided into small holdings as has been advocated by many economists in recent years and actually put into practice in Mexico and some of the newly-formed republics of Europe. Such a course would neither have been politic nor have added to the total of cultivable land in the republic. The President chose the alternative plan of attempting to provide new lands for colonization by improving and increasing the irrigation systems of the coastal valleys.

In 1904, under President Pardo, the government had already begun an inventory of the land and water resources of the coastal valleys. President Leguia took up this task, and in 1920 a tentative plan was drawn up which would bring under cultivation a million acres of new land scattered over twenty valleys. In June of that year work was begun on a scheme for the irrigation and colonization of about 20,000 acres in the Pampas Imperial in the Cañete valley 80 kilometers south of Lima. The project was carried out under the direction of an American engineer, Mr. Charles W. Sutton, who is in charge of the government's irrigation work and who must share with President Leguia the honor of giving to Peru the new era of prosperity which now seems assured to her. In 1923 the work was completed, and in 1924 the land was offered for sale in lots of 12½ acres or more at approximately $110 per acre. The entire area was sold in 24 hours to men from every social class. In less than two years after the sale of the land 60 per cent of it was under cultivation and was producing an annual crop equal in value to more than half of the total capital invested.

The wisdom of the plan being thus confirmed, work was immediately begun on the second major project in the government's agenda—the irrigation of the arable land in the Department of Lambayeque. (For reports by Mr. Sutton and articles on the project by F. P. Farrar see various issues during 1924, 1925, and 1926 of the *West Coast Leader*, a weekly magazine published at Lima.) The Department of Lambayeque has been chosen as the site of the second important project because it is said to offer a greater area of good soil capable of irrigation than any other department of the republic. It is estimated that there are 750,000 acres of superior soil in this department which can be irrigated. The department is watered by five rivers, which are intermittent throughout a large part of their channels and which, under the present system of irrigation, provide a full perennial supply of water to only about 62,000 acres. An additional 125,000 acres under cultivation are supplied with water only during the flood season. It is planned to supply full irrigation to these 187,000 acres now under cultivation and to add to them 168,000 acres more, making a total of 355,000 acres under full irrigation when the project is completed.

The plan calls for the consolidation of the flow of the five rivers that water the department; the construction of storage reservoirs and drainage canals to regulate their flow and provide against destructive floods like that of 1925; and the construction of diversion canals and eighteen miles of tunnels, one of which will be ten miles in length, through the main cordillera of the Andes by which the flow of the Huancabamba River, a tributary of the Marañon, will be brought into the channel of the Olmos River on the Pacific side of the divide. By means of tunnels and canals the flow of these six rivers will be united in a single system with their natural fluctuations balanced by a storage reservoir on the Huancabamba River and a storage reservoir and diversion canals on the Chancay River. On the Chancay River storage will be provided by a dam fifty meters high to be constructed at Carhuaquero. It will permit the maintenance of a full supply of water throughout the year on the sugar lands of the Chancay delta, permit lands on the northern edge of the delta to receive the benefits of the early floods of the Chancay River, and diminish the damage now caused by excessive floods from the Chancay watershed. It is of immediate necessity and will be the first item in the project to be completed. The second storage reservoir, which will also be provided by a 50-meter dam on the Huancabamba River on

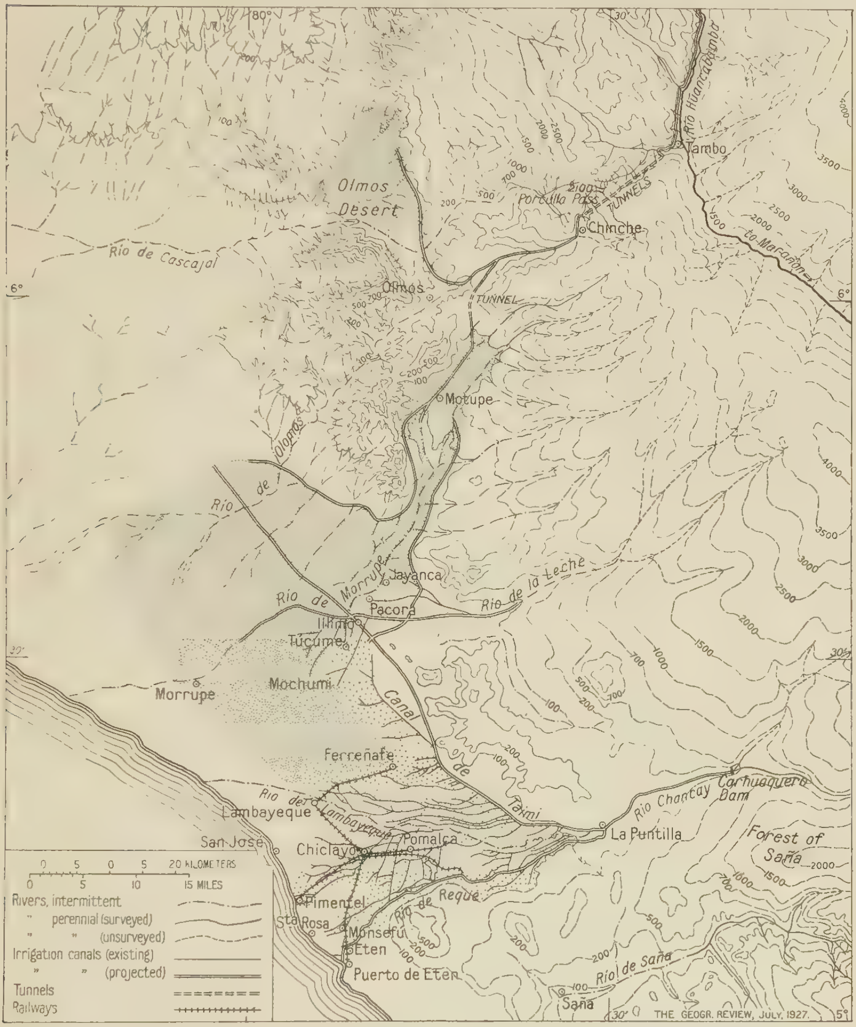

FIG. 1—The Lambayeque Irrigation Project. Based on compilation prepared for the Piura sheet of the American Geographical Society's Millionth Map of Hispanic America from original surveys made by the Irrigation Commission and the Jayanca sheet of the Carta Nacional of Peru. Elevations are in meters. Where the proposed canals follow river beds or existing canals only the symbol for the canal is given. Approximate areas now under perennial or summer irrigation shown by open stipple: approximate extent of new lands to be brought under irrigation shown by close stipple. The entire stippled area will have full perennial irrigation when the project is completed. Scale 1: 1,500,000.

the Atlantic side of the main cordillera, will be for the sole purpose of maintaining a full supply of 700 cubic feet of water per second to the Huancabamba diversion canal.

It is estimated that the cost of the completed project will be $20,000,000. The irrigation works alone embrace six major diversion tunnels, 150 miles of trunk canals, 18 miles of tunnels, and 100 miles of trunk outlets. In addition it will be necessary to build some 300 miles of roads capable of carrying heavy motor traffic. Labor has had to be recruited from distant parts of the republic, camps built, and food supply organized. The sanitation and water supply of fifteen towns will have to be provided. On account of the disastrous floods of 1925, which destroyed much incompleted work and which required the efforts of a large part of the personnel of the government's Department of Irrigation in restoring irrigation work in other parts of the coast, the scheme is now only about 20 per cent finished. All of the preparatory work, however, has been completed (see Charles W. Sutton's letter in the *West Coast Leader*, March 22, 1927).

Meanwhile the government's irrigation engineers have also been engaged in other parts of the coast. The work, now under way, of restoring the irrigation systems of the Piura and Chira valleys destroyed by the floods of 1925 will ultimately irrigate 95,000 acres. In the Pampa of Chilca and the Pampas of Huambo two projects are being carried out, by private capital but with government assistance, which will irrigate 10,000 acres and 17,500 acres, respectively. In the past six years the government has supplied full irrigation to 40,000 acres. It is expected that the work can now be carried on at the rate of at least 40,000 acres a year and that in 1931 a total of 160,000 acres will have been given full irrigation, while summer irrigation will be provided for an additional 80,000 acres. The fact that at present the exports of cotton and sugar from 640,000 acres of land under cultivation in the coastal valleys of Peru are about equal in value to the exports of copper, silver, and petroleum is a sufficient guarantee of the practicability of the project.

EUROPE

The Populous Lowland of Valencia. The crescent-shaped Valencian lowland on the eastern coast of Spain has an area of only 2000 square kilometers, yet it supports by the fruits of its soil more than 500,000 people. Such an agglomeration of human beings is common enough in an industrial region, but it is a phenomenon worthy of study when it exists solely through an agricultural relationship to the environment. The explanation of this dense human group is given by Johann Sölch in "Die Landschaft von Valencia" (*Geogr. Zeitschr.*, Vol. 32, 1926, pp. 337–359). Professor Sölch finds it in the sequence: mountains-snowfields-streams-alluvium-irrigation, without which the area would be a real desert.

The Valencian area as a whole may be divided into four geographic sub-regions from the human-use standpoint:

(1) Coastal zone—unhealthful and scantily peopled by fishermen and sailors.

(2) Campo regadio—the huertas and vegas—the area of intensive irrigated cultivation and dense population.

(3) Campo secano—the unirrigated agricultural zone of moderate population.

(4) Highland border (600–1000m. elevation)—the zone of sparse population which exists chiefly by rearing sheep and cultivating cereals.

The summers in Valencia are so dry that the natural vegetation is a grass steppe, salt steppe, heath, or sclerophyllous woodland. Rains begin torrentially in September or October, causing violent and destructive floods. During the winter precipitation diminishes to where it barely suffices for the winter crops; but the snow which falls on the mountains to the west is an accumulated wealth for the following summer. A second maximum in rainfall comes in spring; and this is the most important factor in the economy of the province, for it supplies irrigation water in the early summer. North-northeast winds during winter often cause ruinous frosts, and in spring the temperatures may fall below freezing because of rapid nocturnal radiation under cloudless skies. Hot, dry summer winds bring Saharan conditions, frequently so insufferable that the natives cover the streets with awnings. The rainfall averages under 500 millimeters and occasionally falls to 350 millimeters or even less. Sometimes one-fourth of the entire rainfall occurs in a single day, thus aggravating the drought through the rest of the year.

The lowland of Valencia is a young alluvial plain filling an old bay between two prongs of the mountains which here extend to the edge of the sea. The plain has been formed through the coalescence of the deltas of the Jucar and other streams, which have cut deep gorges in their upper reaches and brought down vast quantities of rich sediment from the encircling limestone mountains. The sands, marls, wine-red clays, and black silts thus formed are in the main fertile.

Romans, Moors, and the modern Spaniards have done wonders with water and soil in Valencia. Here, as early as 1239, severe laws were worked out to govern the use and conservation of water. Today the stringent water laws of Valencia contrast strikingly with the milder laws in force in the better-watered parts of Spain. Professor Sölch gives an exceedingly good description of these laws as expressions of social viewpoint and social organization in relation to a semiarid environment.

By the careful use of stream and ground water there has been created in the Valencian lowland one of the most luxuriant landscapes in the entire world. In addition, the county of Valencia applies to its soils more than 16 per cent of all the commercial fertilizer used in Spain. Land has been subdivided until the average family is supported on half a hectare of land. Valencia produces 80 per cent of the Spanish rice crop; and this, supplemented by vegetables, feeds her laboring classes. Fancy wine grapes, strawberries for the Madrid market, and winter vegetables for northern Europe are produced in great quantities. One hectare of land often carries 250–265 orange trees (yielding 50 pounds a tree annually), corn grows to a height of five or six meters, wheat gives astonishing yields, clover is cut nine or ten times a year, mulberry trees furnish three cuttings annually, and fancy vegetables grow to huge size. So important is water to this high-pressure system of production that it is proverbial throughout Spain that both the men and the fruits of Valencia are soft: "La carne es yerba, la yerba agua; los hombres mujeres, los mujeres nada."

A brief but effective picture of the dominance of irrigation in the life of the Valencian lowland has also been given recently by J. F. Unstead in a paper "Geographical Regions Illustrated by Reference to the Iberian Peninsula" (*Scottish Geogr. Mag.*, Vol. 42, 1926, pp. 159–170). G. T. RENNER

The Distribution of Population in Galicia, Spain. "Distribución geográfica de la población en Galicia," by J. Dantín Cereceda (Junta para ampliación de estudios e investigaciones científicas, Centro de Estudios Históricos, Madrid, 1925) is the first of a series of regional population studies which when completed will provide a detailed population map for the whole of Spain. The present contribution is described by its author as having only "un mero valor documental." It comprises a colored map on the scale 1: 800,000 and a brief explanation of method and results. Señor Cereceda's work on the natural regions of his country is well known, and he promises a geographical interpretation to accompany further studies.

Statistics were furnished by the Census of 1920 and the "Nomenclátor de las ciudades, villas, lugares, aldeas y demás entidades de población de Espana" (1924). On the map population is shown by equal-density curves. Fifteen grades are used—from under 20 to over 300 people per square kilometer (52 to 777 per square mile). Towns of over 2000 are abstracted.

The population density of this northwestern region of Spain, 188 per square mile on an area somewhat less than Massachusetts and Connecticut together, is well above the average for the country (111). It is essentially rural. Eighty per cent live in towns and villages, but these are small: of the 25,098 unit groupings, 95 per cent have under 200 people. The figures are interesting: 13,188 have less than 50 inhabitants; 7393 have 50–100; 3355 have 100–200. Only 31 places have over 2000 people, and several of these cannot be properly described as urban. Only 7 of the 31 towns have over 10,000 people. Coruña has over 50,000. As one would expect, the areas of densest population are on the coasts where the fishing industry flourishes and finds excellent harbors in the rias. Densities here are far from uniform, however. A notably sharp gradient occurs east of Finisterre where conditions are not so favorable, and the locality (Jallás) stands out as a distinct enclave amid characteristic coast populations. Save for the fertile Miño valley in Orense the interior populations are much less dense, the lowest figure being attained in the mountainous southeast.

Place Names and Plant Geography Illustrated from the Vicinity of Munich. Place names have something in common with fossils. Extraordinarily enduring, they tend to persist after profound changes have taken place in the language, race, and nationality of the people who use them and even in the very features of the landscape to which the names were first applied. In countries that have been occupied by man for a long time, the place names may serve the historian much as fossils serve the geologist or artifacts the archeologist—by giving a clue to conditions that prevailed in the past and for which little or no other evidence is available.

One of a variety of ways in which the geographer may profit by the study of place names is illustrated by Wilhelm Troll in an article entitled "Die Bedeutung der Ortsnamen für die pflanzengeographische Forschung" (*Zeitschr. für Ortsnamenforschung*, Vol. 2, 1926, pages 12–31). The student of plant geography often wishes, so far as possible, to reconstruct the natural vegetation cover of a region as it existed before modification by the hand of man. In doing this he may supplement strictly botanic or phytogeographic evidence by the examination of documentary records and place names.

Troll reports the results of a study of the place names in the environs of Munich. In common with other parts of Germany much of this region is now covered with spruce and other coniferous growths, which have taken the place of the hardwoods that prevailed before the Thirty Years War. We find here a frequent use of the toponyms *Buche* and *Loh* and their derivatives, either standing alone or in combination. The term *Buchet* is now applied in the vicinity of Munich not only to beech but to spruce groves. *Loh*, which is etymologically related to the Latin *lux*, means, strictly, a light wood; but Troll finds cases where open, wholly unwooded meadows are called *Loh.*

Not only has Troll been able by the compilation and comparison of data of this sort to show that hardwoods formerly prevailed as a whole over large parts of his area, but he also has succeeded in tracing even the detailed pattern of the former forest cover by correlating the critical place names with the edaphic conditions. In many instances the distribution of the place names containing the stems *Buche*, *Loh*, and *Heide* correspond very neatly with the distribution of various types of glacial deposit. For instance, the *Buche* names seem to be restricted to the moraines and to the outwash plains of the older glacial epochs. The outwash plains of the latest glacial epoch (Würm) were covered largely with mixed oak forest. The approximate areas of former heathland—once much more widespread than now—are seen from the distribution of the word *Heide* (heath) as a toponym to have been restricted to the long tongues of gravel deposited by northward-flowing glacial streams.

Irish and Welsh Speech in the British Isles. The map, Figure 1, of the Gaeltacht, the Irish-speaking districts of Ireland, is reproduced from the *Annales de Géographie* for March, 1927. It is based on the detail maps (1 mile to 4 inches) of the Coimisún na Gaeltachta, whose report was published by the Dublin Stationery Office in 1926. A similar map and a full analysis are given by Edwin Fels in "Die Wiederbelebung der irischen Sprache" (*Petermanns Mitt.*, Vol. 73, 1927, pp. 37–41).

The census of Irish speakers was made in July and August, 1925, while agricultural statistics were being gathered and before arrangements had been made for the general census of 1926. The results are a matter of concern for those who see in the language the strengthening of the national spirit. The number of Irish speakers has declined from 436,758 in 1911 to 299,249. At the same time the Gaeltacht has lost 13 per cent of its total population, which is a considerable share of the 5 per cent loss for the Free State as a whole (1926). The remoteness of western Ireland has been a protection for the language in the past, but the economic conditions associated with that remoteness have reached a state where they now are a factor in the decay. Large numbers have had to emigrate, while those at home remain in "grinding poverty" (compare the article on Inishmore elsewhere in this *Review*). Irish speech has become "a symbol of poverty and ignorance." The Gaeltacht is largely coterminous with the Congested Districts as first outlined. Little has been done to relieve the worst areas, where conditions are "so serious that every responsible authority hesitated." The Commission recommends the breaking up of the western grasslands and their resettlement into economic holdings by Irish-speaking families. If the language is to be saved, however, it is in education that the chief means is to be found.

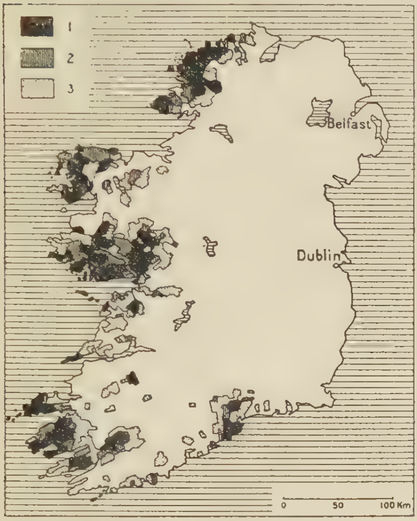

FIG. 1—Irish-speaking districts of Ireland: 1, over 80 per cent of the population speak Irish; 2, 60 to 80 per cent; 3, 30 to 60 per cent. Reproduced from M. Demangeon's note "La situation linguistique et l'état économique de l'Ouest Irlandais" in the March, 1927, number of the *Annales de Géographie.*

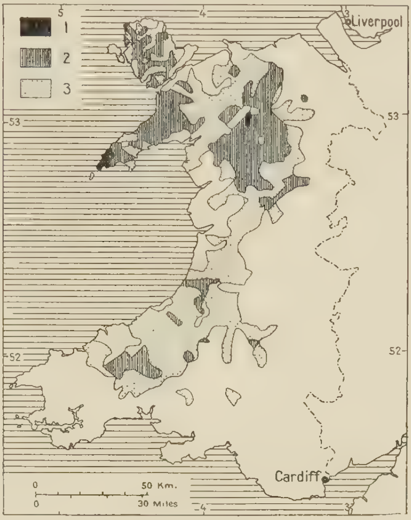

FIG. 2—Welsh-speaking districts of Wales: 1, over 80 per cent of the population speak Welsh; 2, 50 to 80 per cent; 3, 30 to 50 per cent. Redrawn from Trevor Lewis' paper in the September, 1926, number of the *Annales de Géographie.*

Some similarities are seen in the survival of Welsh in Wales (Trevor Lewis: Sur la distribution du parler gallois dans le Pays de Galles, d'après le recensement de 1921, *Ann. de Géogr.*, Vol. 35, 1926, pp. 413–418). Over the entire country a certain number of Welsh speakers are to be found but a considerable percentage only in the remote parts—the northern peninsula and the "holy" island of Anglesey; the high valleys of the northern mountains, which conserve very ancient racial elements; the mountainous zone of the center and south: poor country, a land of emigration. Religion—the non-conformist movement beginning in the eighteenth century—has been a powerful factor in the preservation of the language, while the present development is closely bound up with renaissance of Welsh nationalism in the nineteenth century.

ASIA

The Sultanate of Muscat and 'Oman. 'Oman, the eastern projection of Arabia, is a country of rugged mountains carved out by the erosion of uplifted plateaus. Were it not for this bold relief 'Oman would probably be as unrelieved a waste as the unknown deserts that border it on the west. The highlands, however, catch and condense moisture brought by the monsoons from over the Indian Ocean, producing periodic rains which supply enough water in the wadis to support an agricultural population that, for Arabia at least, is relatively dense. The mountains run out to the north as a long promontory, which nearly closes the entrance to the Persian Gulf. Here the coast has been drowned, forming deep, fiord-like bays, not long ago the haunt of pirates. Winding back among hills of appalling aridity, these bays support a scanty fish-eating population amidst heat that is probably as fierce and overwhelming as anywhere on the earth's surface. Farther south the mountains swing away from the shore of the Gulf of 'Oman as a shallow arc, leaving a narrow, curving coastal plain over two hundred miles long. Where this arc again touches the coast, Muscat, nominally capital of 'Oman, clusters tightly about its tiny, landlocked harbor. Muscat was famous in the sixteenth century as a great Portuguese naval and commercial base and in the seventeenth and early eighteenth as the capital of a veritable Arab empire—that of the *saiyyids*—with possessions on the east coast of Africa even as far as Zanzibar. Closely linked with lands beyond the seas, Muscat is effectually cut off from its own hinterland by the hills, so that the sole means of direct communication with the interior is over "narrow and rough footpaths suitable only for pedestrians and donkeys." Caravans come down to Matrah, two miles away, whence goods have to be shipped to Muscat by boat.

At the present time the Sultan—of the same line as the great *saiyyids*—"has authority only in Muscat and a stretch of coast to the north and south, which can be intimidated by British gunboats." The interior is quite independent; several of the powerful tribes, however, are strongly sympathetic with the Wahabis, and British statesmen are apprehensive of a possible Wahabite conquest of the entire country.

Inner 'Oman has been visited by only about half a dozen Europeans. The latest extended journeys were those of Sir Percy Cox. Although these were undertaken in 1903 and 1905, an account of them was not published until 1925 (Percy Cox: Some Excursions in 'Oman, *Geogr. Journ.*, Vol. 66, 1925, pp. 193–227). In 1925 Capt. G. J. Eccles and a party representing the D'Arcy Exploration Co. carried out a geological reconnaissance of the coastal plain and valleys heading back into the mountains northwest of Muscat. The results of this exploration with a general account of the geography and political situation in 'Oman (from which the above quotations are taken) is published in the *Journal of the Central Asian Society*, Vol. 14, 1927, pp. 19–42.

Structural Features of the West-Siberian Plain. Based upon the results of previous investigations and researches, some of the most important of them published since 1914 or still in manuscript, Y. S. Edelstein contributes to the fifth volume of the *Izvestya* of the West-Siberian Section of the Russian Geographical Society a "Geological Sketch of the West-Siberian Plain." This region, comprising almost the entire basin of the Ob and extending eastward to the Yenisei, forms one of the great structural plains of the world. Except in the border zones skirting the highlands which surround it, its strata, so far as has been ascertained, lie flat and undisturbed. Only in the southern part of the plain proper, in the regions about Omsk, the fossil fauna of which were disputed over for many years, are there evidences of formations as old as Pliocene and Miocene exposed over any considerable areas. Elsewhere, with rare and insignificant exceptions, are found only Quaternary deposits, mainly of sands and clays, the latter largely of loess-like character, forming the foundation for the black soil of the south-central zone. Glacial deposits extend over a northern portion much more restricted than in European Russia, hardly reaching south of 62°.

The elevation of the entire plain is extremely low, being less than 250 feet in even much of the southern portion, and most of it has been submerged again for considerable periods since its first emergence in the late Paleozoic or early Mesozoic era. Even slight epirogenic disturbances have sufficed to bring about extensive transgressions of the Arctic Ocean. Such transgressions, in the Mesozoic era and well into Tertiary times, reached a junction with the waters of the Aralo-Caspian basin and abraded the older dislocated rocks of the eastern slope of the Urals to a level with the plain itself. Cut off finally on the north and southwest and partly freshened by streams, the remaining waters formed throughout the Miocene and Pliocene epochs an inland sea which was brought into contact with the Altai and Kirghiz highlands by a slip and depression of the eastern portion of the plain along a fault marked by the present course of the Yenisei.

The formation of successive series of dunes along the shore of this sea as it receded is held by some writers to account for the long, low ridges with northeasterly axes which give the only variety to the topography of the southern steppe zone. But this explanation of them is not wholly satisfactory, and several others have been suggested, the simplest being that, since the two principal river arteries of this zone, the Ob and the Irtish, had become established since preglacial times in a northwesterly course, their tributary streams would take northeasterly and southwesterly directions, leaving such ridges between their valleys. A further tilting of the plain from south to north in the postglacial period is indicated by river terraces showing a relative lowering of the base of erosion due to the rise of the southern region, while maritime deposits above the glacial boulder clay in the north are evidences of a new transgression of the sea caused by temporary depression.

The data upon which this sketch is based are scanty, and it is subject to revision by further investigations, for which there is much room. It is noteworthy that in an appended bibliography of about a hundred titles, about one-third deal with the bordering mountainous regions rather than the plain itself, while many more are of general or incidental character. Nevertheless the sketch is a valuable summary of the results arrived at and the problems on which fresh light is needed in the study of this important region.

J. V. Fuller

Physiographic Effects of the Japanese Earthquake of 1923. An excellent study by Naomasa Yamasaki, professor of geography in the Tokyo Imperial University (Physiographical Studies of the Great Earthquake of the Kwanto District, 1923, Reprint from *Journ. Fac. of Sci., Imp. Univ. of Tokyo,* Sec. 2, Vol. 2, 1926 (pp. 17–119), describes the physiographic effects of the Japanese earthquake of 1923, there known as the Kwanto earthquake, from the name of the coastal lowland on which Tokyo is situated.

Before the block faulting, which gave the stamp to the pre-earthquake topography, the district appears to have been a lowland of degradation, worn down on folded Paleozoic and Tertiary strata and more or less veneered with sands and gravels. In consequence of strong downwarping and faulting, the lowland became indented by the large and deep, south-opening Sagami Bay, 80 kilometers across by 110 kilometers long, in the mouth of which the volcanic island of Oshima has been built up; and also by the smaller and shallower Bay of Tokyo, which branches northeast from Sagami Bay. The Boso Peninsula stands between the two bays and the Pacific on the east; and the Idzu Peninsula, bearing the several medium-sized volcanoes of the Hakone district, stands between Sagami Bay and Suruga Bay of similar origin on the west. Conversely, in consequence of upfaulting, several crustal blocks, now maturely dissected, gained sub-mountainous forms; the loftiest of these being the Tanzawa block, about 25 kilometers northwest from the head of Sagami Bay, with summits from 1500 to 1670 meters high. Besides these stronger depressions and elevations numerous blocks of smaller and diverse displacement are described in detail; their scarped margins, with relief of 200 or 300 meters, are ravined, and their back slopes are dissected by consequent streams, the initial back-slope surface being in some cases well represented in tabular hilltops of accordant heights; but one river, the Hikichi, in the lowland north of Sagami Bay, is regarded as antecedent, as it is believed to maintain its original course into and across an uplifted block.

One of the smaller downfaulted blocks, now forming an aggraded trough about 15 kilometers wide, trending southeast, leads Sakawa River to the head of Sakawa Bay, beneath which the trough is continued in an axial depression with depths of 1000, 1500, and 2000 meters, increasing southeastward to the ocean. This trough appears to show the maximum downward displacement of the region, while the Tanzawa block shows the maximum upward displacement. Next east of the trough of Sakawa River, on the lowland margin, is the uplifted and tilted Yurugi block, rising northwestward, or inland, to a scarped point, and sloping southeastward so as to be continued through the bay in a tilted block, with depths of from 500 to 1000 meters, next east of the axial trough.

The epicentrum of the earthquake was determined by Imamura from seismographic records at Tokyo to be in the depressed axial trough near the middle of Sagami Bay, of which a revised naval chart, No. 102, was published in 1915. Four hydrographic surveying parties were sent to the bay after the earthquake, and 83,286 new soundings were made there. A comparison of these with soundings of earlier dates shows a sinking of 140, 110, 100, and 210 meters along the axial trough and of 120 meters west of Oshima; while a part of the tilted block in the northeast section of the bay next east of the axial trough was elevated from 100 to 250 meters, and an area northwest of Oshima was elevated 100 meters or more. Doubts have been expressed as to these measures of changed depths, but it is precisely in detailed work of this kind that the Japanese excel. The shores of the bay were uplifted from 1.5 to 2.00 meters, laying bare many strips of abraded rock platforms. This small elevation of the shore belt gradually decreased inland, until a belt of land trending west from Tokyo and then southwest into the Idzu Peninsula was found to be depressed from 0.3 to 1.6 meters. The changes of level on the land are shown in great detail on a colored map, 1:200,000, accompanying a volume entitled "Scientific Japan, Past and Present," Kyoto, 1926, prepared for the Third Pan-Pacific Science Congress, held in Tokyo in 1926. (The same volume also contains an article on "The Great Earthquake of S. E. Japan on Sept. 1, 1923," by Dr. Imamura, professor of seismology in the Tokyo Imperial University.) Many small scarps and clefts were developed among the jostled blocks of the coastal lowland; certain large rice fields, previously level, were given a gently waving surface like that of ocean swell; other fields were slightly dislocated by many small step faults; many landslips occurred in the deep valleys of the Tanzawa mountain block. But these minor changes all appear to be of secondary importance: the main movements were renewed displacements on the strong faults which long ago produced Sagami Bay; the Kwanto earthquake of 1923 may therefore be regarded as merely the latest of many previous shocks in this district of jostled fault blocks.

W. M. Davis

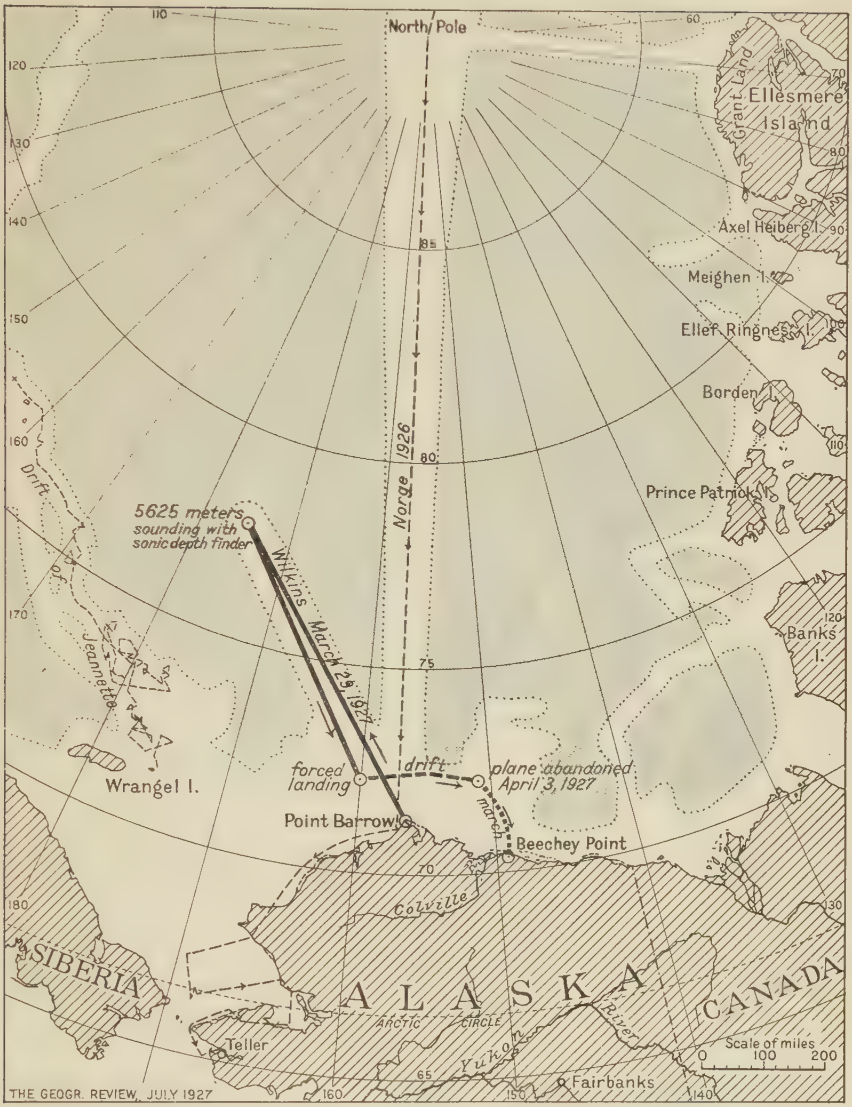

FIG. 1—Map to illustrate Captain Wilkins' route March 29 to April 14. The heavy solid line represents the course by airplane; the broken line, drift on the ice; the dotted line, march over the ice. Unknown areas of the Polar Sea are shaded. Scale 1 : 20,000,000.

POLAR REGIONS

Captain Wilkins' Arctic Expedition of 1927. Some results of Captain G. H. Wilkins' Arctic work of this year are now known in outline. The plans of the 1926 expedition were continued (see *Geogr. Rev.*, Vol. 16, 1926, p. 149; Vol. 17, 1927, p. 317). The first objective was penetration of the unknown area between the drift of the *Jeannette* and the route of the *Norge.* On March 29, in a Stinson plane with Ben Eielson as pilot, Wilkins took off from his base at Point Barrow, intending to fly some 500 or 600 miles northwestward. Five hours out, having flown 553 miles, the plane was forced down. The landing spot was selected and a perfect landing accomplished. The geographical position was longitude 175° W., latitude 77° 45′ N. Through a hole cut in the ice, here three and a half feet thick, soundings were taken with a Behm echo sounding machine of the light and portable type furnished by the American Geographical Society. From four detonations two echoes that checked were obtained. Despatches received state the depth as 5625 meters or 18,450 feet—the greatest depth reported in the Arctic. While data are not yet available for checking the exact figure the sounding may be taken as over 5000 meters and as further evidence in support of Nansen's theory of a deep polar basin.

After three hours' work the party was able to take off, only to be forced down again in a few minutes, once more achieving a perfect landing. Thus Wilkins' ideas regarding the character of the ice covering this part of the Polar Sea seem to be confirmed. He asserts that frozen into the Alaskan ice are great floes of old ice which behave essentially like land masses, the younger ice piling up on their borders while the interior remains substantially level. On taking off again a strong wind southwest by west was encountered, necessitating an allowance of 30° for drift and greatly reducing the speed. In consequence seven hours later, when 470 miles of the return trip had been made, the gasoline gave out. They were now in latitude 72° 15′ and longitude 160° W., 83 miles northwest of Barrow in the stormy coastal belt. The floe they landed on drifted rapidly to the east, a direction contrary to the usual westward drift, which would have taken them towards Wrangel Island. By April 3 they had drifted 167 miles to the east, to longitude 151° W. and latitude 72° 15′. Here Wilkins decided to leave the plane and strike south for the Eskimo settlement and trading station of Beechey Point, at the mouth of the Colville River. With an improvised sled they set off shoreward, after 12 miles crossing from a floe drifting eastward to one drifting slowly westward. Wilkins' calculations proved exact: in twelve days they reached the station. The going was exceedingly rough, especially over the shore ice, where they dispensed with the sled. A good deal of game was seen on the march, but provisions carried with them sufficed for their needs. Nights were spent comfortably in snow houses. Eielson had a badly frozen finger, but otherwise no serious mishaps befell them.

From Barrow, Wilkins flew via Wainwright and Kotzebue to Fairbanks in order to make preparations for further exploration. On May 29 he flew back to Barrow, crossing the Brooks Range by the Anaktuvuk Pass. If conditions had permitted he would have undertaken a second trip across the ice. The season, however, was far advanced and the spring breakup had come early this year. The proposed flight would have penetrated the most important remaining unknown area, that is the region northeastward where Crocker Land and Bradley Land have been reported. At the moment of going to press it seems probable that Wilkins' plans will be continued next year.

Kerguelen Island. Kerguelen Island, discovered by the Chevalier de Kerguelen in 1772 and claimed by him for France, received little official notice until 1893 when it was formally annexed by that nation. So unattractive as to be termed "Isle of Desolation" by its early visitors, the island has for the most part remained hidden in its mists, being visited only by whaling vessels and occasional scientific expeditions.

Kerguelen lies midway between the Cape of Good Hope and southwestern Australia in latitude 49° S. With a length of 85 miles and an area of 1400 square miles, the coast line is penetrated by so many deep fiords that no part of the island is more than 12 miles from the sea. Soundings support the theory that Kerguelen was once part of an extensive land area that included the present Crozets, St. Paul, and Amsterdam Islands. The island itself is volcanic with basaltic rocks and hot springs. Bearing evidences of glaciation, its mountains rise in series of jagged peaks, Mt. Ross attaining an elevation of 6120 feet. The scenery is magnificent, for the steep-sided valleys open out upon the deep fiords, snow fields cover the interior, and occasional glaciers descend from the heights. Although the presence of trees at one time is indicated by the petrified tree trunks, the island is now devoid of tree growth. The present vegetation is of great antiquity, having no affinity with that of Africa. The rocky coasts are covered with tufted, grassy growths. The Kerguelen cabbage, much valued for its antiscorbutic qualities, takes its name from this island. Vegetation disappears above an elevation of 300 meters, and the soil becomes a field of basaltic rock with intervening spaces of sand and shallow pools. The interior is a complete desert, neither birds nor insects remaining there.

Lying within the zone of the cold Antarctic drift, with a low temperature and high precipitation, the fall of rain and snow is considerable. The chief characteristic of the weather is the frequency of storms and high winds at all times of the year. These storms blow principally from the west. A high wind is the rule each week, and any month may bring snow. Yet the meteorological reports of one expedition show that fully half the sky was generally clear at some time in the twenty-four hours (S. J. Perry: Report on the Meteorology of Kerguelen Island, *British Meteorol. Office Publ. No. 37*, 1879; B. M. Varney: Climate and Weather at Kerguelen Island, *Monthly Weather Rev.*, Vol. 54, 1926, pp. 425–426).

Kerguelen is frequented by fur seals and sea elephants, and the surrounding waters by whales. Whaling vessels early discovered this, and the exploitation of these animals has led to their depletion. Aside from the seasonal visits of the whalers, no commercial exploitation of the island was undertaken until 1893, when the Bossière Brothers, who had been engaged in raising sheep in the Falkland Islands, obtained the whole island as a concession from the French Government. The more orderly exploitation of the seals and elephant seals, together with the setting aside of certain parts as a national park, points to a permanent and valuable trade in these animals. Sheep raising, for which the Bossière concession was granted, is still in an experimental stage (Ct. Sauvaire-Jourdan: La mise en valeur des îles Kerguelen, *La Nature*, No. 2743, 1926, Oct. 30, pp. 273–279).

OCEANS

The Oceanography of the Eastern North Atlantic. The very marked differences in climate and habitability that characterize Labrador and Greenland on the one hand and northwestern Europe on the other can in no wise be attributed to differences in latitude, for these countries face each other across the intervening waters of the North Atlantic Ocean along the same parallels of latitude. These differences arise primarily from differences in the oceanographic conditions of the eastern and western parts of the North Atlantic Ocean. The circulation in this ocean is such that the warm waters of the Gulf Stream are carried toward its northeastern rim, making it possible for the winter winds, which here are southwesterly, to ameliorate an otherwise more northerly climate. The countries facing the eastern North Atlantic are thus very profoundly modified in their climatic features by the oceanographic conditions of the waters washing their shores.

To the elucidation of these oceanographic conditions the veteran Norwegian oceanographers, Bjørn Helland-Hansen and Fridtjof Nansen, present a detailed study in "The Eastern North Atlantic" (*Geofys. Publikasjoner*, Vol. 4, No. 2, Norske Videnskaps-Akad. i Oslo, 1926). This study is based principally on their own observations made during five cruises in the *Armauer Hansen* in the years 1913 to 1924, but use is made also of the data provided by other expeditions in these regions. In this connection it is interesting to note that, although the observations made by the authors extended to a depth of more than a thousand fathoms, the *Armauer Hansen* is a small sailing vessel, with auxiliary motor, of 58 tons' burden and about 80 feet long.

On the basis of these observations, which are given in detail in three tables and summarized in a number of dynamic charts, the authors present a picture of the physical conditions in the eastern North Atlantic. In the region west of Europe they find these physical conditions "dominated by the great North Atlantic Current, popularly known as 'the Gulf Stream'." Coming from the west this North Atlantic Current passes over the Atlantic Longitudinal Ridge, turns southwestward and divides into two branches, the main body of the current turning northward while the other branch turns southward. A continuation of the northerly branch finds its way into the Norwegian Sea.

In the distribution of temperature and salinity in this area another factor becomes prominent and modifies somewhat the simpler features due to the North Atlantic Current, especially at some distance below the surface. This factor is the intrusion of a considerable mass of saline and relatively warm Mediterranean water. At a depth of about 600 fathoms Helland-Hansen and Nansen find the influence of this water from the region near the Strait of Gibraltar to extend as far north as Ireland.

Attention is directed by the authors to the importance of vertical oscillations in connection with oceanographic observations. They present evidence in support of such oscillations partaking of the periodicity of the tides. The observations appear to indicate a period of half a day near the coast and a period of a day farther out in the open sea. These are matters about which very little is yet known, and in directing attention to the vertical oscillations the authors state that these oscillations "have obviously to a great extent some connection with the tides; but how the tidal wave can produce vertical movements of such dimensions in the different strata of the sea seems to us at present to be inexplicable. We have here a phenomenon of fundamental importance to Oceanography, which has to be made the subject of special methodical investigations."

Interest attaches to a short series of current observations made on Rockall Bank, out in the open sea some 200 miles due west of the Hebrides. Here a rotary tidal current was found, the direction of rotation being distinctly clockwise. In discussing these observations the authors call attention to the fact that from the generally accepted direction of the tidal wave in this region a counterclockwise direction of rotation might be expected. The thesis recently elaborated by H. U. Sverdrup in his "Dynamic of Tides on the North Siberian Shelf," that the rotary character of tidal currents on continental shelves arises primarily from the deflecting force of the earth's rotation rather than from the interaction of tide waves traveling in different directions, might be put forward to explain the action of the current here; for in consonance with Sverdrup's theory the direction of rotation of the tidal current in the northern hemisphere, except where influenced by special hydrographic features, should be clockwise.

In the foreword to their study the authors state that the present treatise "makes no claim to have reached definite conclusions in regard to a number of highly important questions; for in spite of the very ample material in the form of observations there are still great gaps, and far more complete and systematic investigations will be needed before the problems can be definitely solved." However, in the observations made by the authors and in the discussion of these observations and their correlation with previous data, a considerable step forward has been made not only in arriving at a better understanding of the conditions in this region but also in a clear statement of the nature of the factors and problems involved. H. A. Marmer

The Actual Numbers of Deep-Sea Soundings. In an article under the above title in the *Scottish Geographical Magazine* for July, 1926, Henrik Renqvist summarizes the present state of knowledge of the depths of the open sea as illustrated by the actual numbers of soundings in the various oceans. The present is an appropriate time for such a survey, since the use of acoustic methods of sounding the oceans marks a new period in oceanographic work. Where a deep-sea sounding with wire was a matter of hours, a similar sonic sounding is a matter of minutes.

Starting with the assumption that the last edition of the Prince of Monaco's bathymetric map shows practically all the deep-sea soundings made heretofore, Renqvist arrived at the number in each ocean by the simple process of counting. He lists the number in each of the three oceans—Atlantic, Indian, and Pacific—and then computes the average density per unit area. Taking a deep-sea sounding to be one greater than 1000 meters (approximately 3300 feet, or 550 fathoms) he finds the total number of such soundings in the three oceans to be, in round numbers, 15,000, of which 6100 are in the Atlantic, 2500 in the Indian, and 6300 in the Pacific.

Taking the areas in each of these oceans in which the depths are greater than a thousand meters and dividing by the number of soundings given above, Renqvist finds that in the Atlantic Ocean there is one sounding for each 5500 square miles, in the Indian Ocean one for each 10,500 square miles, and in the Pacific one for each 10,000 square miles. This means that in the Pacific Ocean there is, on the average, but one sounding for areas greater than that of the State of Massachusetts.

Obviously the figures for the average density of soundings do not tell the whole story. Within the regions of the more moderate depths (1000–4000 meters) the number of soundings is relatively much greater. Furthermore, the soundings are not evenly spaced, being most dense along lines of soundings, especially those made in connection with the laying of telegraph cables. If the 15,000 deep-sea soundings be plotted as dots on a chart, the resulting net would be one of irregular mesh, and a number of these meshes would each be nearly as large as all Europe.

H. A. Marmer

The Tide at Tahiti. The rise and fall of the tide is brought about by both sun and moon, the moon, however, playing the leading rôle; or, as it is put colloquially "the tide follows the moon." This is perhaps best evidenced by the fact that throughout the world, almost without exception, the tide like the moon comes later each day by fifty minutes, on the average.

Tahiti furnishes a striking exception to this general rule. Here the tide appears to follow the sun, high water coming every day about noon and midnight and low water about six o'clock in the morning and six o'clock in the evening. This peculiar behavior of the tide at Tahiti has been known for some time. In "Omoo," which appeared in 1847, Herman Melville states "The Newtonian theory concerning the tides does not hold good at Tahiti; where, throughout the year, the waters uniformly commence ebbing at noon and midnight, and flow about sunset and daybreak." Writers of the more popular type of travel books have been less restrained than Melville and either state or imply that at Tahiti the tide ebbs and flows with unvarying regularity never changing in time from one year's end to another. Indeed, a recent popular book quotes a mariner as saying that from the verandah of his club at Papeete he could tell the time of day within a quarter of an hour by looking seawards and seeing where the water stood!

Our knowledge regarding the tide at Tahiti has been meager, for it has been based on a few short series of observations made a number of years ago. Recently, however, at the instance of the U. S. Hydrographic Office, an excellent series of automatic tide records covering several years has been secured by Mr. Harrison W. Smith of the Massachusetts Institute of Technology, who was sojourning in Tahiti. An analysis of these observations has been made by the tidal mathematicians of the Coast and Geodetic Survey, and the results are now at hand.

The mean range of the tide at Tahiti is 0.8 foot. At full and new moon, when the so-called spring tides occur, the range increases to a little over a foot, while at the time of the moon's first and third quarters—neap tides—the range is but little more than half a foot. In general it may be said that high water comes a little after noon and midnight, and low water a little after six o'clock, both morning and evening. But it must be emphasized that this is only on the average. From day to day the time of the tide varies, but this variation only infrequently is as much as three hours from the average values. During spring tides, when the rise and fall is most noticeable, the time of tide varies but little from the average values. The principal lunar component of the tide (in the harmonic notation M_2) has an amplitude of 0.29 foot, and the principal solar component (S_2) an amplitude of 0.26 foot. In other words, here the solar component has very nearly the same amplitude as the lunar, whereas generally it is less than half as large.

Two explanations for this anomalous behavior of the tide have been put forward. The earlier one was based on the assumption of two tide waves coming from different directions, the lunar constituents of which had approximately equal ranges but were six hours apart in time, so that the high water of the one coincided with the low water of the other. The lunar tide was thus very largely neutralized, which permitted the solar tide to become very nearly as prominent. The later explanation is based on the stationary-wave theory of the tide which conceives the tidal movement as due to systems oscillating about nodal lines. Under this theory Tahiti lies near one nodal line of a lunar oscillating system, making the lunar tide here small.

H. A. Marmer

MATHEMATICAL GEOGRAPHY

Oscillatory Changes in the Earth's Radius. When all known factors have been taken into account, theoretical prediction of the moon's position during certain periods has been known to be as much as fifteen seconds of arc in error. At present it is an accepted hypothesis that the effect of tidal friction is responsible for a gradual retardation in the rate of the earth's rotation; but this, being a secular change, does not account for the fluctuations in the moon's apparent movements. Ernest W. Brown, in the *Transactions of the Astronomical Observatory of Yale University* (Vol. 3, 1926, pp. 205–235), presents the evidence which shows that the fluctuations of the apparent movements of the moon and sun are real and not the results of errors in observation. He suggests an hypothesis to explain the phenomenon and arrives at conclusions that are of importance to the geophysicist as well as the astronomer.

The evidence, an analysis and comparison of all the available material collected since 1621, seems conclusive. The hypothesis is that the observed fluctuations of the moon are due to variations in the earth's rate of rotation, when these are combined with the known effects of tidal friction. Granting the hypothesis, arguments resulting from astronomical data, mechanical laws, and geophysical evidence point to the conclusion that such variations can arise only from vertical oscillations of the whole crust of the earth, the source of these oscillations being oscillatory changes that take place in the isostatic layer or below it. The maximum change of the average radius of the earth needed by the astronomical data is between five inches and twelve feet, according to the hypothesis made as to the depth of the source.

Professor Brown's hypothesis has attracted wide attention, and several reviews of his paper have already resulted. Among these may be mentioned "Les variations dans la rotation de la terre," by J. Boccardi (*Rev. Gen. des Sci.*, Vol. 38, 1927, No. 3), and "The Variation of Latitude and the Fluctuations in the Motion of the Moon," by Walter D. Lambert (*Journ. Washington Acad. of Sci.*, Vol. 17, 1927, No. 6). In the latter paper it is pointed out that "the difficulty with the hypothesis—other than the primal one of finding a cause for the shrinking and swelling—lies in the matter of sea level." Mention is also made of the suggestion by Professor J. W. Evans that "a not unreasonable change in the volume of the circumpolar ice sheets might affect a change in the moment of inertia of the earth sufficient to cause the irregularities in its rotation that are reflected in the apparent errors in the lunar tables."

PHYSICAL GEOGRAPHY

De Geer's Interpretation of Climate by Clay Deposits. In a couple of short papers Professor Gerard De Geer has recently announced remarkable climatic correlations between Sweden and North America and between the northern and southern hemispheres (On the Solar Curve as Dating the Ice Age, the New York Moraine and Niagara Falls Through the Swedish Timescale, *Geogr. Annaler*, Vol. 8, 1926, pp. 253–284; Late Glacial Clay Varves in Argentina, *ibid.*, Vol. 9, 1927, pp. 1–8). The periods of time involved are the Late Glacial and the Postglacial. The method is known to most geographers and geologists from De Geer's earlier papers. It consists in the measurement and comparison of varved clays that register the annual sedimentation in an unmistakable and characteristically banded pattern. Through the work of De Geer in Sweden and North America and of his students in the Himalayas (Norin), eastern North America (Antevs), and Argentina (Caldenius) he is able to put together "curves" of variation that show a striking degree of correspondence, roughly 80 per cent. Of the correspondence itself there can be no doubt, despite marked departures here and there as "accidents" of one sort or another occurred in the drainage systems in which the varved clays were deposited.

Professor De Geer had two major problems to face in extending his correlations across the Atlantic and into the southern hemisphere. He had first to construct a standard of reference, and this he did by working out a Swedish time scale which takes account of the whole interval from Late Glacial down through Postglacial time to the present. Probably not more than a century separates the last records of the series from our own time. A continuous varve series covering the whole of the Postglacial epoch was obtained by Lidén in the Valley of Ångermanälven which "seems to be the only region of the earth, where it is possible to connect the glacigene part of the timescale with our actual [i.e. present] chronology." The finding of varved clays in Postglacial deposits that carry the glacial record down practically to the present supplies a yardstick for the measurement of events in the late history of the earth which has been supplied by no other discovery in earth science since its beginning. The significance of De Geer's studies can scarcely be overestimated, because they shed light upon so many problems that are directly related to mankind. There is shown to be in the first place a very short interval since the close of the Glacial period. The record has been traced back over 18,000 years, and it is concluded that 8700 years of this period represents Postglacial time. The standard year marking the division between these two epochs is taken to be the time of final draining of the greatest ice lake dammed up between the waning ice remnant in the Scandinavian Peninsula and the Scandinavian mountains. It was then that the once extensive glacial masses of northern Europe had practically melted away and their scanty and half-stagnant remnants became divided up into different parts. In a few hundred years more these remnants totally disappeared, leaving only local mountain glaciers as at present.

From this conclusion and the present known facts of man's antiquity it is seen that man occupied the earth long before the last maximum glaciation. It is clear, then, that he must have been seriously affected by these major climatic pulsations and that his occupation of northern Europe must have followed rather closely the retreating ice cap. The rate and manner of reoccupation of the surface by vegetation is only second in interest to that of the human problem involved. From the peat bog records it seems equally clear that vegetation followed closely the retreating ice border. By a comparison of the Swedish and North American varved clays science can refer American glacial and postglacial events to the Swedish time scale. Thus the age of Niagara Falls can be recalculated. To it De Geer assigns a value of 9500 years, rather than the larger values that have ranged up to 25,000 and even 50,000 years. It would require too much space to develop the argument in detail and to show how many relationships of moraines to lake beaches and to varved deposits have to be taken into account in arriving at the final computation. Still more complicated is the problem in the Scandinavian region, where the uplift and warping of the terraces, beaches, and border deposits have formed a tangled record that has required a lifetime to study and interpret. It is perhaps sufficient to say by way of review that the work has been carried out most conscientiously and with a rare devotion.

The most remarkable results of De Geer's method have followed upon a comparison of varve records from Argentina and Sweden. It can be readily understood that the climatic variations of the northern hemisphere may have been synchronous and that deglaciation may have proceeded in a general way uniformly in both Europe and North America. But a complication results when we go into the southern hemisphere. If the change in the thickness of the varves from year to year is dependent upon a solar cause and if that solar cause is shown to operate over the northern hemisphere rather uniformly, we might expect it to be hopeless to attempt a comparison between records from the northern and southern hemispheres, for in the southern hemisphere the variations in temperature might on theoretical grounds be conceived to be in opposite phase—only the warm melting season of each hemisphere is registered in the sediment. But, concludes De Geer, a wave of heat lasted over the *greater part of a year*, thus being registered in both hemispheres. Moreover, there is in the solar curve not infrequently a two-year period representing a sustained maximum as if the heat were carried over from one melting season to another, the continued effect of radiation lasting over a twelvemonth. De Geer suggests a special astronomical study to determine at which part of the earth's orbit the earth receives such excess of heat, so that we may understand the relationship between the beginning and the end of associated northern hemisphere and southern hemisphere summer varves "which together represent the whole of what could be called a *thermal year*." He advances various possibilities and closes thus: "It would be curious indeed, if the olden traces of the sun in clay and mud should lead to new astronomical results."

Thus for the first time there have been correlated certain specific climatic changes over the whole earth, and the changes have been dated with respect to the present. By this wide correlation a framework has been built up whose parts can now be filled in. The main Quaternary glaciations of the earth corresponded in time. They had a common cause in the changes of heat received by the earth from the sun rather than in changes of precipitation. The clays are nature's great recording instrument by which we can not only date events in Late Glacial and Postglacial time but also observe variations in solar radiation itself. This last result is by no means of minor importance. The thickness of the bands themselves seem directly related to the amount of melting and that in turn to the amount of heat received, so that thin varves mean years of lower temperature and thick varves (in general) years of higher temperature. De Geer rightly emphasizes the great importance of such a record of the sun's radiation extending back 18,000 years as compared with the brief instrumental records in meteorology and astronomy.

The next critical steps in checking the chronological correlations will no doubt be taken in North and South America. In New England, Antevs has done more than apply De Geer's method—he has analyzed the fundamental postulates of the method and, more especially, has studied the basis of correlation itself. It is expectable from his brilliant results that modifications, some of them fundamental, will in time be made. This is the natural evolution of scientific thought. No one generation can settle definitively the working of natural laws; even the number of dimensions of our modern world has changed! It is greatly to Antevs' credit that he has concentrated on this great problem and with painfully small sums of money supplemented by complete devotion has carried forward his research along original lines. ("The Recession of the Last Ice Sheet in New England," *Amer. Geogr. Soc. Research Ser. No.*

11, 1922, and "The Last Glaciation with Special Reference to the Ice Retreat in Northeastern North America," a forthcoming volume in the *American Geographical Society's Research Series*.) Many others will in time extend his work, but none we may be sure will surmount greater difficulties.

HISTORICAL GEOGRAPHY AND HISTORY OF GEOGRAPHY

The Islands of the Blessed and Atlantis. Mysterious isles in the far western seas played an important part in the mythological geography of the Greeks—Elysium, the Islands of the Blessed, the Gardens of the Hesperides, Scheria or the Island of the Phaeacians, Syrie, the isles of Calypso and of Circe, and others. Adolf Schulten would seek the prototypes of these in Madeira and the Canaries, with which the Islands of the Blessed (Fortunatae Insulae) were identified by later geographers of antiquity ("Die Inseln der Seligen," *Geogr. Zeitschr.*, Vol. 32, 1926, pp. 229–247). He thinks there is no doubt that the Greeks knew of the Atlantic by 1000 B. C. through contacts with the Phoenicians. These adventurous traders had passed through the Pillars of Hercules at least two hundred years earlier in their voyages to Tartessus (Tarshish), the great silver and tin emporium, which Schulten places near the present site of Cadiz (see Schulten's "Tartessos," 1922). "In the seventh century, the time of the Homeric and Hesiodic poems, Greeks themselves penetrated to the Ocean—Phocaeans, who soon established very friendly relations with the silver city [Tartessus]."

The various attributes of the western isles as described in the Homeric and Hesiodic poems correspond closely to those of an island which Diodorus (Hist., v, 9–10) places off the west coast of Africa. Both have a mild and delightful climate, very fruitful soil, an abundance of woods and streams; and in both man may live almost without effort on the bounty of nature. The island which Diodorus describes can be no other than Madeira. He refers to its discovery by the Phoenicians shortly after the founding of Gades (Cadiz), 1100 B. C., and mentions a subsequent attempt of the Etruscans to establish a colony there—an attempt that was frustrated by the Phoenicians. In the Odyssey an isle of Syrie, the home of Eumaeus, is mentioned and is said to have been visited by the Phoenicians. Schulten believes that this can be no other than Madeira, "which [the Phoenicians] discovered and defended so carefully against foreign visitors, the name Σύριη itself seeming to point to the Phoenicians, or the 'Syrians.'"

Schulten also tackles the Atlantis story and lists no less than sixteen different details mentioned in the Platonic story which might well apply to Tartessus. Atlantis, Plato reported, was said to have sunk suddenly into the sea as a result of earthquakes. "This might well be a poetic explanation of the fact that Tartessus disappeared at one stroke from the horizon of the Greeks after its destruction by the Carthaginians and the closing of the straits [of Gibraltar]. But, perhaps, the story may be taken literally, for it seems that the vicinity of Tartessus had sunk, as well as the city itself. And when Plato says that the Ocean became shallow and impassable owing to the sunken Atlantis, I discern here the influence of Carthaginian reports of shoals and other dangers, given out after the destruction of Tartessus in order to frighten away foreign sailors."

A new theory of Atlantis is proposed by Paul Borchardt (*Petermanns Mitt.*, Vol. 73, 1927, pp. 19–32), who brings the country described by Plato, on the authority of Solon, within the Straits of Gibraltar, assuming that the term "Pillars of Hercules" did not refer to Calpe (the Rock of Gibraltar) and Abyla at the time when Solon heard the story from the Egyptian priest of Sais. The term might have been applied to any temple of Melkart (Hercules), for in these temples two columns were set up as symbols of the god of maritime traders (see also R. Hennig: Zum Verständnis des Begriffs "Säulen" in der antiken Geographie, *Petermanns Mitt.*, Vol.

73, 1927, pp. 80–87). Such a temple stood near the site of Gabes on the Lesser Syrtis, and it is here that Borchardt locates the entrance of the "Sea of the Atlantes," which most students from the time of Plato onward have taken to mean the Atlantic Ocean. This sea, which the earthquake caused to become impassable, Borchardt identifies with a deep gulf that once may have occupied the present site of the Shott el-Jerid west of Gabes and have communicated directly with the Lesser Syrtis. The plain of Atlantis he believes was a broad region lying south of the *shotts*, historical and physiographical evidence seeming to show that in early times this was more fertile than now. The difficulty raised by Plato's reference to Atlantis as an island Borchardt explains away; the word "island" was often used by the classical geographers in speaking of tracts of land well defined by rivers or mountains. He would, therefore, identify Atlantis with northwestern Africa as a whole. He also points out many resemblances between the names given in Plato's narrative and the tribal and place names of this part of Africa.

In a symposium of articles on the Atlantis problem (*Petermanns Mitt.*, Vol. 73, 1927, pp. 143–152) Dr. Albert Herrmann of Berlin defends Borchardt; Professors E. F. Gautier of Algiers and Fritz Netolitzky of Czernowitz attack his theory; and Borchardt himself replies to his critics.

Both Schulten's and Borchardt's hypotheses are more reasonable than much that has been written on this difficult subject. Neither scholar would rake up the bottom of the Atlantic Ocean nor flood the Sahara, doing violence to geology. Borchardt asserts that with the exception of Pierre Termier (see *Geogr. Rev.*, Vol. 3, 1917, pp. 61–66) there is "scarcely a geographer of the present day who believes that within historic times a great island of Atlantis has sunk beneath the Atlantic Ocean." The question, however, is one which will never be definitely settled, unless, possibly, as Borchardt suggests, by means of excavations. Atlantis will long tempt the ingenuity of scholars and lure the uncritical into fantastic realms of pseudo-scientific speculation.

GEOGRAPHICAL NEWS

Obituary

Charles Redaway Dryer. Charles Redaway Dryer died at Fort Wayne, Ind., on March 21, aged 76. [Latterly Professor Dryer adopted "Redaway" for "Redway."] His geographical work was done as a teacher: here he was a pioneer of new ideas and methods, worked out for the most part in the Indiana State Normal School where he was professor of geography and geology from 1893 to 1913.

A generation ago Professor Dryer urged the humanizing of the physical geography of the day. The science was treated "almost as if men only visited the earth occasionally, but did not live on it," he wrote in an autographed copy of his book "Lessons in Physical Geography" (1901) in the Society's library. He was an ardent advocate of the natural-regions conception of Herbertson and made it the culminating part of his excellent textbook "High School Geography: Physical, Economic, and Regional"—revolutionary among American texts when first published in 1911. The idea also permeates his "Elementary Economic Geography," first published in 1916. Professor Dryer also expounded his views in the paper "Natural Economic Regions" in the *Annals of the Association of American Geographers* (Vol. 5, 1915) and in "Studies in Economic Geography" in the *Geographical Review* (Vol. 2, 1916). His practical philosophy is stated in his presidential address before the Association of American Geographers (*Annals*, Vol. 10, 1920). Reference should also be made to two papers on the history of geographical education: "The New Departure in Geography" in the *Journal of Geography* (Vol. 11, 1912–1913) and "A Century of Geographic Education in the United States" in the *Annals of the Association of American Geographers* (Vol. 14, 1924).

GEOGRAPHICAL REVIEWS

THE BRITISH ISLES

ALBERT DEMANGEON. **Les Iles Britanniques.** viii and 320 pp.; maps, diagrs., ills., bibliogr., index. (Géographie Universelle, Vol. 1.) Librairie Armand Colin, Paris, 1927. 80 fr. 11½ x 8 inches.

The world geography series planned by Vidal de la Blache, and already in preparation before the war, is now making its appearance under the editorship of Professor Lucien Gallois. The first volume, "Les Iles Britanniques," is by Professor Demangeon and is a pure delight. Paper, typography, photographs, line drawings are a joy to the eye: it is hardly necessary to say in the preface that the editor has given "every care to the illustration of the volume"—it speaks for itself. To pick out one or two examples only is not easy; one might mention the graphic series of little maps showing the seasonal distribution of the herring fisheries (p. 49); such regional maps as that of the Lake District (p. 147) or of the Northumberland and Durham coal field (p. 155). The fine conception of line is well exemplified in the map showing the distribution of dolmens in western Europe (p. 70).

The text has the exquisite clarity of the line drawings. M. Demangeon's dealing with fundamentals secures simplicity and breadth. "This frequency of contact, this repeated opposition of highlands and lowlands may be considered as the distinguishing feature of the country: the origin of local contrasts, it multiplies the small natural settings, the regional individualities" (p. 20). This with the accompanying map is the keynote of the section on relief. "The relations between the Irish and the English are in fact a page in the colonial history of England" (p. 83) is the thread running through the discussion of these relations. Added to this, careful choice of words and selection of detail create an intimate and penetrating picture. Take, for instance, the author's sketch of Edinburgh," . . . the irregular ground of the site, the gardens and trees, the majesty of the monuments, the distant and picturesque perspectives give the city a charm unique in Great Britain." And "among the great British cities Edinburgh is as unique in its functions as its appearance . . . In this Great Britain which knows not a centralization such as that of France the national temperaments have not been fused in an amalgam . . . Edinburgh is essentially a Scottish capital: . . . it is not a maritime town nor an industrial metropolis: . . . but a town of spiritual values, of science, of law, whose most specialized occupations are printing and publishing with the trades and materials dependent on them. . . "

Or take this picture of the industrial towns of the West Riding of Yorkshire:" . . . they resemble one another superficially as children of the same family. They cover a great area, for the workers live in one-family houses: and these houses, all lined up in interminable rows, are built on identical plan in identical mold: under the clouds of smoke from factories and mills they exude an air of melancholy monotony." And by way of contrast in the rural Vale of York, the old town a capital since Roman days, "whose brilliant medieval past survives in its cathedral and walls: . . . the narrow winding streets, the overhanging timbered houses, the massive tower of the old castle, the ruins, and charming corners breathe of another age and diffuse calm and peace."

Or the Forest of Dean, " . . . a little forested plateau whose rocky walls are washed by the Wye above its junction with the Severn . . . the fine oak wood that has escaped the secular deforestation, the clumps of old beeches and fine hollies

. . . " And its unique coal field, whose mines" . . . worked in the open forest, under the shade and greenery of the trees, escape the sadness of the black country . . . the miners dwelling in the little towns that girdle the border of the forest."

It is seldom that any unfamiliarity is betrayed. In paying just tribute to the University College of Wales at Aberystwyth for the study of Welsh culture (p. 82) the fact is overlooked that, for lack of a natural center in Wales (compare p. 81), the University is constituted by three colleges, in the north, center, and south, and that while the National Library is in Aberystwyth, the National Museum, another expression of the Welsh national spirit, is in Cardiff. In a few instances the distinction between regional and administrative lines might have been a little clearer; in treating of the Welsh border country, for instance. And again mere addition of a statement to the effect that Middlesborough, Darlington, and the Cleveland district are in Yorkshire would have appeased the pride of the reader from that county who finds them described under "Northumberland and Durham." York became the seat of an archbishopric—instead of bishopric—in the seventh century. But such minutiae merely throw into relief Professor Demangeon's remarkable knowledge of and feeling for the spirit of the country.

In treatment the book is well balanced. Following M. Gallois' foreword and an introduction on the individuality of the British Isles and their place in the world are three sections dealing respectively with general considerations, regional studies, and economic life and relation to the Empire. Needless to say, the succeeding volumes of the series, all by well known French geographers, are eagerly awaited.

SCANDINAVIAN WALL MAPS

ALFRED SÖDERLUND, edit. **Europa: Befolkningskarta (Population Map), 1:4,000,000.** In four sheets. Generalstabens Litografiska Anstalt, Stockholm, 1926. 20 kr.

ALFRED SÖDERLUND AND GUSTAV TÖRNBLOM. **Kommersiell Världskarta.** 1:35,000,000. Generalstabens Litografiska Anstalt, Stockholm, 1926.

"Europa" is an admirable colored wall map on the "absolute" point method, a development from Sten De Geer's large map of Sweden and Dr. Söderlund's map of Norway. Cities of a hundred thousand or more persons it shows by red spheres of size proportional to the number of inhabitants, a white "brilliant point" suggesting the sphericity to the eye. The rest of the population is indicated by cleverly placed little red dots a 30th of an inch in size, one for each 5000 persons.

Names of the cities indicated by spheres and about as many more of less size, names of countries, rivers, etc. are in black. Coast lines, seas, and rivers are in blue. The colors are pleasing and transparent. Canals are indicated and mountains located by their names, without relief shading of any sort. A selection of railroads is printed in a clear but unobtrusive gray, like the main sea routes. Beside each city sphere a small number in black notes the number of times 5000 persons it had in 1920; thus, 20 indicates 100,000 persons, which needs rather fuller explanation in the legend than it has obtained. It would have been much better to have indicated the numbers in thousands. Broad bands of gray outline De Geer's "industrial regions." In Russia the southern limit of forests is marked; and in Russia, Finland, Sweden, and Norway, the northern border of tillage.

All this is done without crowding or obscuring the map. The selection of matter to be represented from the multiplicity that offered has been admirably made. The map gives a remarkable picture of human distribution in Europe on an unwontedly large scale; but the scale is none too large for this essential feature of geography which up to the present has suffered incredible neglect. The map should be in every schoolroom where advanced study of Europe is made, in spite of our American shyness of foreign languages, which makes the place names look queer.

The representation of non-urban population by a dot for each 5000 persons is most severely tried in sparsely settled areas like Norway. Where people live on isolated farms or in little villages, it is most arbitrary and artificial to gather 5000 of them into a single spot on the map. Tinting a whole county with one shade of population density was, in general, no further from the truth. The map does not give a good idea of the way the inhabitants of Norway and northern Sweden cling to the coasts and the linear river valleys, as shown on the large maps referred to above, on which a dot represents 100 persons. For the English Midlands, however, 5000 to a dot is none too many, if enough white background is to show through to keep place names clear. So the method called "absolute" is relative after all!

However, De Geer and Söderlund have made it possible to learn needed detail about Norway and Sweden; and the method has been applied most skillfully even in sparse populations, as is proved in the treatment of Iceland by the clever way in which the ninety-odd thousand inhabitants are distributed about the fiords. More detail is here given of the human occupation of Iceland than has ever come under the observation of the reviewer.

"Kommersiell Världskarta" is a clever and distinctive wall map. The map is an oval "Hammer's equal-area planisphere," the equatorial scale being about 1 : 35,000,000. It is neatly printed in colors and not at all overloaded with names. It shows fixed air routes and makes a special feature of telling a Stockholm merchant what language to use in writing to any country. This information embodies the advice of Swedish consuls abroad and is most interesting. For instance, German is to be used in sending orders to Germany, Poland, Czechoslovakia, Austria, Hungary, and Switzerland, and may be used instead of Russian for Russia; for Yugoslavia either German or French; and for Brazil either German, French, or English. For Spain and Spanish America Spanish only is recommended. For Portugal and its colonies, for Italy and colonies, as well as for Egypt and the Belgian Congo English or French should be used. English is to be used for the United States and for the British domains, of course; and also for China, Japan, and Arabia, with the permitted alternative of French. French should be used in French domains and also in Greece, Rumania, Bulgaria, Turkey, and Persia. In Addis Ababa the activities of Scandinavian missionaries have made it possible for the Swedish merchant to write in "Scandinavian"!

Another feature of the map is the annual tonnage of great ports. Sea routes are given as they are actually steered, not as generalized; and there is some indication of temperatures and the ice-drift border.

Readers will get an exaggerated impression of the preponderance of Swedish steamer lines if they take the map at face value. Red seems to be the Swedish color, and all the lines converging on eastern ports in the United States are red. The map is small, and when something had to be left out it wasn't Swedish!

MARK JEFFERSON

Norden. 1 : 1,500,000. In 2 sheets. Swedish text. Lithographic Division of the General Staff, Stockholm, 1926.

This wall map of Fenno-Scandia, Denmark, and vicinity represents an outstanding contribution to the fields of economic and commercial geography and cartography. Its large scale and pleasing color scheme provide for clear legibility at long range. At close range its numerous details are easily read. The data include not only the official reports of the respective countries here delineated but also the researches of such geographers as Sten De Geer, Söderlund, and others.

Elevations above sea level for every 500 meters, to a height of 2000 meters, are shown in varying shades of olive; while ocean depths are indicated by shades of blue for every 500 meters to a depth of 2500 meters. The first 500 meters below the sea are interrupted by one shade to represent the 200-meter contour. Glaciers appear in light mottled blue.

Of particular interest is the distribution of the cultivated areas, colored yellow. In those parts of Sweden and Finland bordering the Gulf of Bothnia and extending an irregular distance inland, delimited for the most part by the landward margin of the coastal plain, the rural population flanks the rivers which flow down to the gulf in parallel directions. Interstream areas are essentially unoccupied. By contrast, in the south of Sweden, in Denmark, and even in southern Finland the farm areas are commonly continuous between streams. The interpretation of the distribution along the rivers differs among geographers, some assigning such reasons as protection and convenience of transportation as fundamental, while others find the attraction of the waters and the food supply offered by them as basic. In any case, a cross section from south to north as revealed by the yellow color emphasizes the relation between the stage of economic development of a people and the element of location.

Appropriate symbols show national and provincial boundaries, sizes of cities, location of villages, castles, churches, cathedrals, national parks, railroad routes, steamship courses with amount of traffic moving along them, and still other political and economic information contributing to a description of man's activities in the region. A small inset map, to show the means of communication between Fenno-Scandia and North Sea points, adds further value. The North German and Polish coasts, Danzig Free State, the new Baltic States south of Finland, and a strip of adjacent Russia shown in some detail assist one in orienting the main areas with respect to Europe and at the same time give good balance to the entire map.

Unfortunately, meridians are numbered with reference to Stockholm, the longitude of the latter east of Greenwich being noted in order to facilitate calculating the longitude of other points east of Greenwich if desired. This arrangement is awkward and seems to serve no good purpose. Parallels of latitude are drawn for each degree, and the subdivision of the degrees is supplemented by figures along the left-hand margin indicating 2.5 centesimal intervals. An index plan involving the standard combination of numerals and letters serves to add further to the convenient use of the map.

EUGENE VAN CLEEF

REGIONAL STUDY IN ESTONIA

J. RUMMA, J. G. GRANÖ, and J. V. VESKI. **Tartumaa: Maadeteadusline, majandusline ja ajalooline kirjeldus.** xvi and 740 pp.; maps, diagrs., ills., indexes. (Eesti: Maadeteadusline, majandusline ja ajalooline kirjeldus, I.) Eesti Kirjanduse Seltsi kirjastus, Tartus, 1925. 9½ x 6½ inches.

The young Estonian state intends to investigate its virgin territory, for the former Russian government was more interested in such parts of its empire as the Ural and the Caucasus, on account of the great economic importance of their mountain lands; whereas the Baltic region, which is but poorly endowed with minerals, was almost completely neglected. In Estonia there has been created for the purpose a Society for Home Geography (Kodu-uurimise Toimkond), which in collaboration with the Estonian Literary Society (Eesti Kirjanduse Selts) intends to publish a great collective work on Estonia in eleven volumes. As the first volume there appears a substantial book on the County of Tartu (Dorpat), entitled "Tartumaa," containing many very useful statistical data. The land and the people of Estonia are the subjects of the investigation, the following questions being treated: location, morphography and geomorphology of the land, waters, vegetation, animal life, regions as well as the settlements, communications and economic conditions, cultural and hygienic questions.

MICHAEL HALTENBERGER

SOME GERMAN WORKS ON POLITICAL GEOGRAPHY

OTTO MAULL. **Politische Geographie.** xiv and 742 pp.; maps, index. Gebrüder Borntraeger, Berlin, 1925. 10½ x 7 inches.

WALTHER VOGEL. **Politische Geographie.** 134 pp.; maps, bibliogr. (Aus Natur und Geisteswelt No. 634, Allgemeine Geographie X.) B. G. Teubner, Leipzig and Berlin, 1922. 7 x 5 inches.

WALTHER VOGEL. **Das neue Europa und seine historisch-geographischen Grundlagen.** 2nd edit. x and 322 pp.; maps, bibliogr. Kurt Schroeder, Bonn and Leipzig, 1923. 9½ x 6½ inches.

RUDOLF REINHARD. **Weltwirtschaftliche und politische Erdkunde.** 196 pp.; maps, diagrs., bibliogr. Ferdinand Hirt, Breslau, 1925. 9 x 6 inches.

Political geography is still merely a term, not a science. It is unnecessary to suppose that it ought to be a science when one undertakes to appraise or to criticize current works on the subject. Necessarily its facts are drawn to a large degree from economics and general history as well as from the fields of international relations and diplomatic history; but the essence of the subject is the geographical basis or background for political events and relationships. Geography offers not merely a technique, such as maps, demographic studies, and statistics peculiarly its own; it offers much more, namely, organized expert knowledge of what we may call the regional set-up of the world. It is peculiarly the function of geography to furnish the scientific basis for a study of man as actually distributed in the world region by region. However much he may respond to economic laws of world-wide scope and however large or small may be the national units that make the political framework of the world, the intimate life of people is much more affected by the regional conditions of their living, the physiography, the climate, the soil, and the special relationships of the local environment.

To seek a meaning from the cultural landscape as derived from the natural landscape is at least understandable; to go further and see culture as a self-stimulating force rise superior to the natural limitations of its place of origin, is sound; and it is true that superior culture is often superior strength and thus a spreading and transforming force. But do we derive inevitably from this a conclusion respecting the justice or injustice of boundaries? By specious scientific systems we may argue for any desired political result. Some of the most important elements of culture seem not to get into the political geographies of continental Europe, namely, ethics, good manners, the elevation of fairness into a fine art, *cultured* living! The historical argument against a given boundary solution is arid. The world moves on. Where do we stand today? What is fair now? To take another aspect of culture—machine power—a single invention may throw a nation into a wholly new economic status. Machinery changed the world in a generation. What do the advocates of "white men's lands" care for philosophic niceties and traditional political modes? If man's culture rises above his environment so does man rise above his culture, if we may express it paradoxically. With many deep roots in his past he yet frames new systems as spontaneously as life succeeds itself. Forms, cultures, judgments, standards float upon a current that flows always in a temporary channel.

In an earlier number of the *Review* (review of Supan's "Leitlinien der allgemeinen politischen Geographie: Naturlehre des Staates," *Geogr. Rev.*, Vol. 14, 1924, pp. 665–666) we criticized a European type of philosophy that attempts to put political geography largely within the framework of the state as at once an expression of culture and the guardian of it. This is to start with a political theory devised to aggrandize the state, and it may have nothing whatever to do with the actual facts of living. We now come to a group of publications that illustrate other aspects of the subject.

Professor Maull's book is packed with historical and economic information from a wide variety of sources, and there are many excellent and attractive illustrations and generalizations respecting the economic and political life of man on the earth. In addition, there are many ingenious ideas and relationships; much matching of the different irregular parts of the world's picture puzzle. But if we look for judgments respecting the political set-up of the world today or if we look for any rational information of use to policy makers in government we find the book singularly deficient. For practical purposes the information is put into unwieldy form, and much of the lore is simply a mass of notes of antiquarian interest but of no practical or theoretical importance in government or geography. To put facts into a series, to invent mnemonic schemes is to achieve neither learning nor science. No one could use such information as a basis of forecasts; one can rarely demonstrate the cause of a given development in any case. One can only suggest reasons for historical unfolding or for possible action today. After all, a map of Europe which shows by broad arrows (p. 637) the different lines of force of the great powers of Europe teaches us nothing that we need to know or have not already learned; and merely as graphics it is open to objection because it is partial. The illustrations of "disharmonic states" (p. 623), as, for instance, the western border of Germany, northwestern Italy, and eastern Persia, bring into juxtaposition environments and cultures so totally different that to classify them as common examples of a principle is to say nothing at all. A prime illustration of the fault of the mnemonic principle is the table on pages 120–121, classifying the nations of the world according to population and area. Again, as a mnemonic this may have usefulness; but as an illustration in support of a discussion of the space requirements of peoples it does not make sense at all. If we compare nations by area we find Germany put in the same general class with Paraguay, and if we compare broad population categories in the same table we find ourselves looking at a group which includes Liberia and Norway and other equally strange bedfellows such as Afghanistan and Chile. The author takes over from Supan the extraordinary table of "colonial quotients," showing the ratio of the area and population of the colonial possessions of the powers with the motherland. Of course England stands at the head with a quotient of 8.4, while Germany has a "quotient" of 0.2; but of what significance is that when the Netherlands has a quotient of 6.2 and Portugal and the United States are respectively 1.7 and 0.1 (p. 125)? Of a similar order is the world map on page 147 showing by excellent symbolism the states having two, three, four, five and more neighbors on their borders. After all, neighborship, if we may so term it, may be the least of one's problems. It is not how many neighbors but what kind of neighbors that counts, and what is the length of the border of friendly and unfriendly neighbors, and how one is situated with respect to one's allies. Thus, too, on page 186, is a discussion of the relation of the geomorphological space types of states, that is the relation of states and state boundaries to the physical set-up. Likewise, plant and animal analogies and homologies are suggested here and there. But all to what purpose?

One can understand much better the two smaller works listed herewith, Vogel's "Politische Geographie," a general discussion of the field (as well as his "Das neue Europa," which deals more fully with each nation), and Reinhard's "Weltwirtschaftliche und politische Erdkunde." The former writes more specifically: his illustrations are fewer, his whole scheme is more modest, his feet are on the ground. Witness his map showing the steppe regions of Central Europe, carefully thought out, showing at a glance more than do a dozen pages of philosophic sleight of hand. He is not unaware of the philosophy of his associates, but he cuts through it to arrive at the specific and the practical and actual relationships rather than at any possible philosophical meanings of such relationships, for the ultimate meanings are really denied to man! Intensely German in spirit and politics, he writes in a form often unacceptable to a non-European; but at least one can make allowance for that, whereas the "philosophy" of his associates leaves only bewilderment.

In a still more specific way Reinhard discusses international relations of raw materials and, in short, the material basis of our civilization. His map illustrations are numerous, his whole style of thought less philosophizing, more apprehensible. He expresses practically no opinions and draws no profound conclusions, but he puts facts into striking relationship and lets the inevitability of their meaning stand in place of personal opinion.

ARABIA AND THE ARABIANS

PAUL W. HARRISON. **The Arab at Home.** xii and 345 pp.; map, ills., index. Thomas Y. Crowell Co., New York, 1924. 8 x 5½ inches.

A. GOODRICH-FREER (MRS. H. H. SPOER). **Arabs in Tent and Town: An Intimate Account of the Family Life of the Arabs of Syria, Their Manner of Living in Desert and Town, Their Hospitality, Customs, and Mental Attitude, With a Description of the Animals, Birds, Flowers and Plants of Their Country.** 325 pp.; ills., index. Seeley, Service & Co., Ltd., London, 1924. 8½ x 5½ inches.

MRS. STEUART ERSKINE. **The Vanished Cities of Arabia.** 324 pp.; ills. Hutchinson & Co., London, n. d. 9 x 6 inches.

Eastern Arabia was the scene of Dr. Harrison's twelve years of field service as a medical missionary. His work for the American mission in the hospitals at Kuwait, in the oases of Nejd, Al Hasa, and Mesopotamia, among the mountains of Oman, and in the open desert, brought him into close contact with Bedouin, townsman, and agriculturist alike. Clearly and forcefully he sets forth the fruits of long observation of the material and spiritual conditions of Arab life in the communities he visited. One cannot but wonder, however, whether these communities are sufficiently typical to warrant the use, without further qualification, of the very broad title, "The Arab at Home."

Dr. Harrison examines minutely the social and economic conditions of Bedouin and oasis life and makes these the subject of illuminating comparisons. To the pearl-diving industry of the Persian Gulf, in which "probably a hundred thousand Arabs are engaged . . . throughout the summer months," Dr. Harrison devotes a chapter of altogether exceptional interest. As a missionary the author was above all concerned with the religion of the Arabic people. Like others before him, he sees in Mohammedanism a reflection of the desert: "Mohammedanism is little more than the Bedouin mind projected into the realm of religion. The Arab faces God as he faces the desert. Here is a vast omnipotent environment, which rules his life and which reduces him to insignificance and even nothingness in comparison. By conformity to its laws he hopes to live, and as a usual thing he can. But there is an element of caprice about the desert which makes it at times utterly cruel and ruthless, and from that ruthlessness no amount of humble acquiescence or of vigilant effort will save him. This is exactly the picture of the Moslem God. Unlimited omnipotence, governed as a usual thing by law, and usually rewarding obedience with His favor, He is still tinged with unaccountable and unpredictable caprice, and is essentially pitiless in His power and magnificence. It is the image and superscription of the desert. Long before Mohammed wrote this picture of God into the Koran, God Himself created it in the desert, and so stamped it on the Bedouin's heart."

The subtitle of Mrs. Spoer's "Arabs in Tent and Town" gives a fairly precise idea of the scope of her book. Years spent in the towns and villages of Syria and along the desert borders, combined with a sympathetic spirit and a knowledge of Arabic, gave Mrs. Spoer rare opportunities for observing the lives of a people, many of whose customs date from the days of Abraham. A gift for winning the confidence of the Arab women enabled her to gain an insight into local traditions, popular mentality, and the intimacies of family life such as few Europeans have been privileged to obtain. She discovered ethical refinements in Arab civilization of which we in the West have no parallel, as, for instance, the Bedouin code of hospitality. For this, the desert environment is, perhaps, ultimately responsible, though Mrs. Spoer asserts that "in its wider and less individual presentation, as active philanthropy, hospitality has always been an inherent part of the religion of the East; a necessary part of Oriental life." Mrs. Spoer's chapters on the weather and on natural history relate mainly to the native's attitude and the folklore regarding these matters. She gives, however, a particularly graphic account of the great invasion of locusts in the Jerusalem district in 1915.

Let us not quarrel with Mrs. Erskine's use of the title "The Vanished Cities of Arabia", though we must confess that on first seeing it our thoughts were carried far southward, to the tombs of Hejr visited by Doughty fifty years ago, or the mysterious city—Gerrha, perhaps—recently found by Cheesman at 'Oqair on the Gulf of Bahrein, or possibly to Sabaean and Himyaritic ruins on the margins of the great southern desert. With none of these Mrs. Erskine is even remotely concerned. The book, with its truly magnificent illustrations, deals with ruined cities in the rift valley of Syria and on the plateau east of the Jordan and Dead Sea—Petra in its cleft rock, the towering Crusaders' castle of Kerak, the ill-fated "cities of the plain": Philadelphia, Gerasa, and others. It is a pleasant combination of history and travel, informative but not heavy. Students of the history of geography will turn to the chapter on the discovery in 1894 and subsequent partial mutilation of the famous mosaic map of Palestine at Madeba, dating from the time of Justinian (sixth century of our era).

NOMAD AND AGRICULTURIST IN WESTERN TURKESTAN

PAUL KUNHENN. **Die Nomaden und Oasenbewohner Westturkestans.** 131 pp.; bibliogr. Heinrich Pöppinghaus, Langendreer, 1926.

Even though its author has neither visited Western Turkestan nor made use of Russian sources, this doctoral dissertation by a young disciple of Passarge is of distinct value. From the point of view of human geography, the region with which it deals is more or less typical of the entire zone of deserts and dry steppes stretching from the Atlantic coast of the Sahara far into the heart of Asia. Hence, many of Kunhenn's observations and conclusions relating to the desert and oasis dwellers of Turkestan would hold equally true for Arabia or North Africa. Furthermore, his treatise is well planned and clearly presented.

The most striking fact in the human geography of the Africo-Asiatic desert and steppe zone is the dualism of the population. Even where they have sprung from the same racial stock, the desert rover and the oasis dweller are different in almost every respect. The distinction between nomad and settler is fundamental, far more profound than the distinction between townsman and farmer in lands of European civilization.

After a brief sketch of the physiography of Western Turkestan, Kunhenn examines the contrasts between the nomadic herdsmen of the steppes and the Sarts, or oasis folk, in respect to social, political, and family life, to religion, law, occupations, means of subsistence, clothing, habitations, manners and customs, and to physical and spiritual qualities in general. Most of these contrasts may be attributed to the differences between the desert and oasis environment. In the desert, man's foremost enemy is nature. Life is a constant struggle for mere existence in the face of extremes of cold and heat, with the menace of drought and famine ever at hand. The nomad is wholly dependent upon his herds, around the preservation of which the entire course of his life revolves. This means periodic seasonal migrations to and from summer pastures among the mountains or on the cooler, damper steppes to the north. In the oases, which cluster along the bases of the mountains and about the deltas of the greater streams far out in the desert, plenty of water is distributed by irrigation over rich fields of loess, and there has grown up an enormously dense population. Here man's primary struggle is with his fellow man.

Kunhenn shows how these contrasting environments have fostered, on the one hand, the hardy, simple, independent, democratic, dirty, meat-eating, and naturally religious nomad, and, on the other, the oasis dweller, effeminate, complex, servile, keen-witted, meticulous about his person, a vegetarian, and, though fanatically Moslem and scrupulous in the observance of religious forms, fundamentally irreligious at heart. Kunhenn considers that Islam is "a typical oasis religion" and that the reason why it was accepted so rapidly in Turkestan at the time of the Moslem conquest is that it was admirably adapted to the mentality of the oasis dwellers. Although nominally accepted by most of the nomads, Islam with them is in reality little more than a veneer over the "Shamanism which they have brought with them from regions further east." The nomad has no genuine conception of the unity and omnipotence of God. In this respect his religious outlook differs essentially from the inborn monotheism of the Bedouin even though both are children of the desert.

The Vegetation of Algeria and Tunisia

Augustin Bernard and R. de Flotte de Roquevaire. **Atlas d'Algérie et de Tunisie, Part IV: Carte de la végétation.** 4 pp.; map, diagrs., ills. Gouvernement Général de l'Algérie, Direction de l'Agriculture, du Commerce et de la Colonisation, Service Cartographique, Algiers and Paris, 1925. 24½ x 21 inches.

René Maire. **Carte Phytogéographique de l'Algérie et de la Tunisie.** 78 pp.; maps, ills., bibliogr. Gouvernement Général de l'Algérie, Direction de l'Agriculture, du Commerce et de la Colonisation, Service Cartographique, Algiers, 1926. 10½ x 8½ inches.

These two publications describe the vegetation of the same area and are accompanied in each case by the same colored phytogeographic map. The map is the work of Professor Maire, assisted by MM. Battandier, G. Lapie, P. de Peyerimhoff, and Dr. Trabut. The former publication gives a concise description of the vegetation and carries 13 half-tone illustrations, which are well selected to portray the larger aspects of the principal vegetations. A series of four profiles is given with the same coloring used in the phytogeographic map. The second publication describes the vegetation in greater detail and is accompanied by 60 illustrations of individual species. The vegetation of Algeria and Tunis falls into three natural subdivisions, the lightly forested coastal region, the steppes which skirt the landward side of the broken mountain region, and the desert region which lies adjacent to the Sahara. The coastal region undergoes a dry warm season of 4 to 5 months but receives an annual rainfall varying from 400 to 1600 mm. Its prevailing vegetation is forest of evergreen oaks (*Quercus Ilex* and *Q. suber*) and deciduous oaks (*Q. lusitanica* and *Q. afarez*), together with the olive and species of elm, ash, alder, and poplar. On the mountains and plateaus lying within 100 kilometers of the sea there are forests of pine (*Pinus halepensis*); on the coast there are a few small areas of *Pinus pinaster;* and on the highest elevations there are small areas of cedar (*Cedrus atlantica*). On some of the smaller mountains bordering the northern edge of the Sahara open forests of *Quercus Ilex* and *Pinus halepensis* are to be found. A small arborescent juniper (*Juniperus phoenicea*) occurs in extensive open stands along the border of the Sahara at elevations lower than those occupied by the oaks. Another small coniferous tree, *Callitris articulata*, is abundant in western Algeria and occurs in smaller areas in Tunis.

Between the forested and desert portions of Algeria are extensive steppes, with 200 to 350 millimeters of rainfall, characterized by an open stand of plants less than a meter in height. The characteristic plants of the steppe are grasses (*Stipa tenacissima* and species of *Aristida, Bromus*, and *Koeleria*) and shrubs (notably *Artemisia herba-alba* and *A. campestris*). Many other species of plants are found in the steppe, including numerous ephemeral herbaceous plants. The vegetation of the Sahara is well characterized by both of the authors as being only "rarefied steppe."

FORREST SHREVE

THE COASTAL DESERT OF SOUTHWEST AFRICA

ERICH KAISER. **Die Diamantenwüste Südwest-Afrikas, zugleich Erläuterung zu einer geologischen Spezialkarte der südlichen Diamantfelder, 1: 25,000, aufgenommen von W. Beetz und E. Kaiser.** Mit Beiträgen von W. Beetz, J. Böhm, R. Martin, H. Rauff, M. Storz, E. Stromer, W. Weissermel, W. Wenz, K. Willmann. Vol. 1, x and 321 pp., maps, diagrs., ills.; Vol. 2, vii and 536 pp.; maps, diagrs., ills., index. Dietrich Reimer (Ernst Vohsen), Berlin, 1926. 9½ x 12½.

The reader's satisfaction in the extent and thoroughness of this report will be enhanced by the excellence of the illustrations. A rarely beautiful series of photographs shows typical landscapes region by region as seen from the ground and from the air. Desert filling has nowhere been better illustrated than in Plate 14 which shows by air photograph a group of mountains all but buried under desert waste. The colored frontispieces to the two volumes hint at those inexpressible compositions of light and color that give the desert its peculiar power to haunt the memory. Volume 2 has been thoughtfully provided with two packs of stereoscopic photographs. An elaborate index furnishes a key to the whole work, and there are tables, diagrams, and sketches to illustrate almost every phase of the discussion. Volume 1 is accompanied by a set of detailed relief maps, geological maps and sections, and analyses of the various physiographic and geologic elements. For example, map No. 11 shows in great detail the belt of wandering dunes north of Angras Juntas, one of the best maps of its kind yet published.

The detailed geological maps are of especial interest because the principal object of the work is illustrated in them: the geological development of the region and the origin of the diamond-bearing deposits. The diamonds occur in sandy beds associated with the coast. It is concluded that they had their origin in the interior as elements associated with igneous rocks. The breaking down of these igneous rocks distributed the diamonds throughout a broad sheet of alluvial deposits. These deposits were later reworked especially in the Eocene, and the diamonds concentrated along drainage lines where they are found today.

The most striking feature of the work is the large colored topographic map on the scale of 1 : 25,000, showing by thirteen tints the relief of the land from below sea level to 240 meters above sea level. The large scale and the minute division of the vertical elements of the relief have provided one of the most satisfactory representations of desert topography in existence. In addition to the means of color clever use has been made of shading. Accompanying the map is a separate text published by the Geographical Society of Munich (*Mitteilungen*, Vol. 19, 1926, pp. 38–75). This describes the field methods employed, the development of the cartographic style, and gives a brief summary of the main physiographic features. The underlying structure consists of a series of folded rocks whose axes run for the most part parallel to the coast. The rock itself is mostly gneiss and schist intruded by granite and covered in places by stratified rock. Secondary structural lines are rift valleys traversing the primary structural lines at an angle and emerging at the coast where they form notable elements in the coastal physiography. Besides a high series of coastal terraces whose origin is uncertain there are raised beaches to the height of 40 meters as well as at intermediate levels.

Especially interesting is Kaiser's discussion of the desert topography and the part played by wind in its formation. In the descriptive pamphlet accompanying the map are two block diagrams (pp. 62 and 63) which show the unlike characteristics of two regions: the one shows dominant deflation by strong winds, the other dominant alluviation through the relative weakness or absence of winds. He concludes that southwest Africa has long been subjected to desert conditions, some ancient sandstones showing characteristic dune structure. With the invasion of the middle and upper Eocene sea the climate was modified, moister conditions prevailing. The Miocene was marked by a return to semiarid conditions, and in later times there has been progress to the state of extreme aridity which marks the region today. He concludes that the driest phase of the climate has not been felt in historical times, nor even in human times, but in a pre-human epoch; and that at the present time southwest Africa enjoys a moister climate owing to moderate marine invasions.

ON THE MINERAL WEALTH OF THE FAR EAST

H. FOSTER BAIN. **Ores and Industry in the Far East: the Influence of Key Mineral Resources on the Development of Oriental Civilization.** With a chapter on Petroleum by W. B. Heroy. Preface by E. F. Gay. viii and 229 pp.; maps, diagrs., bibliogr., index. Research Publs. of the Council on Foreign Relations, New York, 1927. 9 x 6 inches.

WILFRED SMITH. **A Geographical Study of Coal and Iron in China.** With an Introduction by Percy M. Roxby. 83 pp.; maps, bibliogr., index. University Press of Liverpool Ltd., Hodder & Stoughton Ltd., London, 1926. 5 s. 9 x 6 inches.

C. Y. HSIEH. **General Statement on the Mining Industry (1918–1925).** 4, iv, ii, and 362 pp.; map. *Spec. Rept. Geol. Survey of China*, No. 2, December, 1926, Peking.

In his introductory chapter Mr. Bain refutes two commonly held opinions regarding the Far East—the "untold wealth" that Westerners have always associated with Cathay and the complementary view that the mineral wealth is "unknown" and "almost wholly unmeasured." Actually, says Mr. Bain, a large body of data exists which has not yet found its way into general publications. To this his book, clear and succinct and fortified with an extensive bibliography, furnishes a key, and it reaches the conclusion that, with minor exceptions, "the Far Eastern countries are characterized by deficiency in mineral resources rather than by abundance." At present the contributions of the Far East to the world's mineral products are small save for antimony and tungsten, of which China furnishes respectively 80 per cent and 63; tin, of which Malaya, Siam, and the Netherlands East Indies furnish 60 per cent and China 6 per cent.

The situation would seem to be different with China's coal reserves, which are great whatever estimates be taken. Estimates vary widely. Drake, for the International Geological Congress of 1915 ("Coal Resources of the World") gave a figure of nearly 1,000,000 million tons, a value comparable to the reserves of Europe. On a different basis the Geological Survey of China gave a conservative estimate of 23,000 million tons, a figure which new studies are constantly increasing (see below). In the particular instance of fields in northern Shensi and western Shansi Clapp and Fuller arrive at estimates exceeding Drake's. With the known data it is "impossible to reconcile the figures," says Mr. Bain, but both he and Mr. Smith (see below) regard Drake's figure as being probably on the right order of magnitude.

It is otherwise with iron ore. Here, as regards China we have Tegegengren's careful report, "The Iron Ores and Iron Industry of China" (*Memoirs Geol. Survey of China*, 2 vols. and Atlas, Peking, 1924). He points out that the total quantity of iron ore, 950,000,000 tons (both actual and potential), "would be consumed by the iron industry of the United States within less than nine years." Thus China needs to conserve her resources for her own future development. The situation is worse in Japan, whose domestic supply is "entirely inadequate to her needs." Among the Far Eastern countries the Philippines and the Netherlands East Indies are also potential producers of lateritic iron ores, but with them the question of coal arises.

Succeeding chapters deal with the other "tonnage" minerals, sulphur and the sulphides, and with petroleum, the non-ferrous metals, and the non-metallic minerals. There follows a chapter of wide interest on "conditions affecting mineral development in the Far East." Men and money and the less tangible factors that will control industrialization of the Far East are considered, briefly but wisely, with China as the case in point. A final chapter is entitled "What of the Future?"

Mr. Smith's excellent little book has the distinctive feature of a geographical background. Chapter I considers China's coal and iron in relation to structure; but, as their economic significance depends also on other geographical factors, in Chapter II he takes up a survey of the deposits by natural regions "each of which possesses some unity of economic life . . . and each of which promises to develop some regional specialization of industry." Chapter III, from the historical angle, discusses briefly the early use of the two minerals in China, the beginnings of large-scale industry through Western contact, and the lines of future advancement. Every large coal-mining enterprise in China is related to railroad communications, and consequently with one exception (Pinghsiang) all are in northern China (see his map on p. 58).

The relation of the coal and iron resources to general industrial development is taken up in the last chapter. Already there are hints as to the future. The Fushun coal field of Manchuria has bean oil and bean cake factories and is introducing the manufacture of chemical by-products. Tatung, on the Peking-Suiyuan railroad, has a woollen factory. The northern fields have back of them the pastoral products of a vast zone in northwestern China and Inner Magnolia. The present distribution of cotton mills, immature as the industry now is, foreshadows establishment of the major manufacturing districts in the Yangtze delta, the Central Basin, and the fringes of the northern plain.

The Geological Survey of China's report on the mining industry is dated December, 1926. The main text is in Chinese, but the more important tables are printed in English also, and there is an English preface. Of special interest is the statement of a reëstimate of the coal reserve giving a total of 217,626 million tons. The report is accompanied by a map showing distribution of the coal fields of China on a scale of approximately 1: 6,750,000, which may be "compared with profit with that of Wilfred Smith." The "variable nature of the data available for different regions" is pointed out, and the reader is cautioned to use the map with reserve "especially so far as the southern or southwestern provinces are concerned." Summary tables give the value of the total mineral production of China (including Manchuria and Outer Mongolia) for 1925 as nearly $258,000,000, of which the metallic minerals, chiefly iron, tin, and antimony, comprises $67,000,000 and coal the bulk (85 per cent) of the remainder.

THE MINERAL RESOURCES OF SOUTH AMERICA

RICHARD STAPPENBECK. **Karte der Minerallagerstätten von Süd-Amerika.** Scale 1 : 3,750,000. Dietrich Reimer (Ernst Vohsen), Berlin, 1926. M 100. 16 x 11 inches.

OTTO MAULL. **Südamerikas Bodenschätze als Weltreserve und Machtfaktor, auf Grund von Richard Stappenbecks "Karte der Minerallagerstätten von Südamerika."** *Zeitschr. für Geopolitik,* Vol. 3, 1926, pp. 774–788.

Interest in the mineral deposits of South America has been increasing during the past few decades with the result that there have been many demands made all over the world for accurate information. The data that have been collected have not been readily accessible. Partially to satisfy this demand Miller and Singewald published their volume on "The Mineral Deposits of South America" in 1918, in which an attempt was made to bring together and summarize existing information, part of which was original but much of which was obtained from the literature or from individuals and mining companies. An adequate map of the continent showing the location of the mineral deposits was considered desirable but could not be included in the volume, and resort was had to the inclusion of small maps of various countries and regions. Without the knowledge of the writers of this volume Dr. Richard Stappenbeck had been collecting data for the preparation of a similar work. After the appearance of their book, he abandoned his former idea and confined his attention to the preparation of a map showing the occurrences of the various mineral deposits of South America. Its publication was long delayed on account of the financial situation in Germany after the war, but with improved conditions the map was published in 1926.

Dr. Stappenbeck was well prepared to undertake the task to which he set himself on account of his first-hand acquaintance with many of the mineral regions of Argentina, Chile, and Peru where he spent 16 years in geological investigations. Only one who has attempted to collect information concerning various parts of South America can properly appreciate the large amount of careful work involved in his undertaking. It is more than a mineral map in that, in addition to the use of 76 symbols representing different mineral products, groups, or varieties of minerals, he has also shown the location of railroads, aerial tramways, oil and water pipe lines, blast furnaces, smelters, coke ovens, and oil tanks and has given many data concerning the navigable streams and water powers, exploited and unexploited.

The scale of the map, almost 60 miles to the inch, does not permit the representation of all the important mineral deposits in certain sections. To overcome this difficulty insets of certain sections on a large scale are given. These include: the gold and platinum placers of the Choco, Colombia (1 : 1,950,000); the highlands of Cundinamarca, Colombia (1 : 1,600,000); the mining district of Central Peru (1 : 1,000,000); the gold mines of Carabaya and Sandia, Peru (1 : 1,600,000); the iron, manganese, and gold districts of Minas Geraes, Brazil (1 : 1,150,000); the mineral deposits of Chile, between Rancagua and Tocopilla (1 : 1,000,000).

Another inset, on the same scale as the main map, shows the location of the important mineral deposits of Central America with a small enlargement of the gold and silver districts of eastern San Salvador.

There is no doubt but that many persons familiar with certain portions of the continent will note inaccuracies in the map; but in the present state of our knowledge of South America exact information for the preparation of an accurate map does not exist. The examination of those portions with which the reviewer is acquainted leads to the conclusion that the work has been done with great care, and the author is to be congratulated on the result. He appeals to the users of the map for new data and criticisms in order that future editions may be more complete.

The publishers have done their part well in that the printing of place names is clear and legible and the symbols in eight colors are readily distinguishable. The map is published unmounted in six sections.

Largely on the basis of Stappenbeck's map Otto Maull has written an essay on "Südamerikas Bodenschätze als Weltreserve und Machtfaktor." One cannot fail to be impressed with the wide variety of mineral products and their abundance in the Andes and the Highlands of Brazil and their infrequency in the great central portion of the continent where, if they exist, they are deeply hidden from view by the thick sediments unassociated with igneous rocks. South America is having its mineral deposits developed rapidly. Besides the mineral districts so well known—such as the nitrate districts of Chile, the copper of Peru and Chile, the vanadium of

Peru, the diamonds, manganese, and monazite of Brazil, the gold of Colombia, the bauxite of the Guianas, and the tin of Bolivia—it may well be that in the future the continent will be called upon to furnish in quantity other mineral products required by the industrial nations of the globe. Petroleum occurrences are widespread and, although largely unexploited, are regarded by many as sufficiently promising to cause South America to take rank eventually with North America in the production of petroleum.

BENJAMIN LEROY MILLER

A CONTRIBUTION TO THE BIOGEOGRAPHY OF ECUADOR

F. M. CHAPMAN. **The Distribution of Bird-Life in Ecuador: A Contribution to a Study of the Origin of Andean Bird-Life.** xiii and 784 pp.; maps, ills., bibliogr., index. *Bull. Amer. Museum of Nat. Hist.*, Vol. 55, 1926. 9½ x 6 inches.

As Dr. Chapman has stated in his earlier publication, "The Distribution of Bird-Life in Colombia: A Contribution to a Biological Survey of South America"(*Bull. Amer. Museum of Nat. Hist.*, Vol. 36, 1917), the purpose of his studies of the bird life of the Andes has been rather to discover the geographic origin of South American bird life than to identify new species. (For a review of Dr. Chapman's earlier volume see Charles C. Adams: The Zoögeography of Northwestern South America (after Chapman), *Geogr. Rev.*, Vol. 10, 1920, pp. 101–107.) His problem, as presented in both this work and the one on Colombia, is to "ascertain the effects on the distribution and evolution of bird-life of the elevation, in comparatively recent geologic times, of a mountain system, the central base of which lies near the equator while its summits reach perpetual snow, the wings extending continuously to the Temperate Zone at the south and, with some breaks, to the same zone at the north." The book is based on specimens collected between 1912 and 1926 by numerous expeditions of the American Museum of Natural History and many additional specimens purchased from local collectors. It is indicative of the intensive activities of the Museum that the total of Ecuadorean specimens in the Museum's collection is more than 13,500 and that, of the 1357 species and 151 subspecies recorded from Ecuador, all but 33 are represented in the Museum's collection and in most instances by specimens from Ecuador. A large part of the volume is devoted to distributional lists of these specimens.

Dr. Chapman's faunal zones and their altitudinal boundaries as established in Colombia and accepted over a large part of the tropical Andes by botanists as well as zoölogists were found to be essentially the same in Ecuador as in Colombia. Wide local differences were noted in zonal boundaries between the Pacific Coast of Ecuador and that of Colombia, but the apparently local nature of these differences seems only to emphasize the relations between temperature and the zonal boundaries and the need of further intensive studies of these relations. In Ecuador even more than in Colombia the lack of even approximately accurate topographic maps and of meteorological records has handicapped Dr. Chapman's work.

Of Dr. Chapman's discussions the most interesting to both geographers and geologists is probably that of discontinuous ranges and his suggestions as to the exploration of the phenomenon. The explanation does not seem to lie in lack of suitable habitat, since many habitats suitable to certain species completely lack them, and he dismisses the probability that the discontinuous phenomenon is due merely to the bird's potential mobility and to fortuitous circumstance. He maintains that the casual establishment of isolated bird colonies is infrequent and cites among others the case of whole families of birds containing hundreds of species which are common on the mainland from Guiana to Mexico and totally lacking in the West Indies. Climatic change due to glaciation and volcanic activity which at some period may have exterminated the bird life of large areas are offered as probable but at best only partial explanations.

The volume contains a brief history of Ecuadorean ornithology; brief discussions of the physiography, the distribution of forests, and the general climatic conditions; a bibliography; and a list of collection stations—all of which are of interest to geographers.

ECOLOGICAL GUIDE TO AMERICA NORTH OF THE EQUATOR

V. E. SHELFORD AND OTHERS, edits. **Naturalist's Guide to the Americas.** Prepared by the Committee on the Preservation of Natural Conditions, of The Ecological Society of America, with assistance from numerous organizations and individuals. xv and 761 pp.; maps, ill., indexes. The Williams & Wilkins Co., Baltimore, 1926. $10.00. 9 x 6 inches.

Dr. Shelford undertook an important and difficult project when he planned a descriptive catalogue of the American areas in which natural conditions for plants and animals exist particularly suitable for scientific study and for preservation. Probably over 75 persons have contributed to this encyclopedic volume printed in small type and in double columns and with the general plan recalling Mills's "The International Geography."

As an introduction to the general descriptive part there are nineteen short articles devoted to the uses, values, and management of "natural" areas from various points of view, æsthetic, educational, scientific, economic, and administrative.

The great bulk of the volume is devoted to the description of the various sections in political, administrative, or natural units, beginning in the far north and working south to the equator. Naturally the fullest account is given of the United States and Canada. The islands of the Atlantic, such as the Bermudas, Bahamas, and West Indies are included and, in the Pacific, the Galápagos and the Philippines. South America south of the equator is omitted, no doubt on account of the difficulty of securing authors; and to this extent the title of the work is misleading.

The various accounts contain a vast amount of valuable descriptive information in readily accessible form. It would be necessary to consult hundreds of volumes or papers to find what is here concentrated in one, and there is in addition much that is new. The sixteen line maps will prove valuable to many students who desire a graphic view of the broad biogeographical relations. Naturally these different regional accounts are of very unequal value. Some are prepared by well informed students who are familiar with their regions and have modern ecological ideas; others have such a strong floristic and faunistic bent or bias that the results are not entirely satisfactory in a volume intended to emphasize the ecological aspect.

The volume concludes with a list of persons who coöperated in its preparation and a directory of local, state, and national organizations interested in conservation matters. The directory, however, is very incomplete.

The reader cannot fail to note the numerous small errors and omissions that naturally lead him to expect similar errors in other parts with which he is not so familiar. Now that we have the basis, a revised edition could give us an exceedingly valuable and reliable reference work. On the whole, as has been said, the volume is a very valuable contribution which will be particularly useful in reference libraries and to many geographers and naturalists and will be a tool in constant use among botanical and zoölogical field workers.

Many years ago when the reviewer began to stress the value of studying natural conditions and of preserving "vanishing" natural data there were some who were inclined to look upon this as more or less of a fad. Since that time the study of natural unmodified nature has been increasingly recognized, especially among ecologists. It is probably correct to say that, as a group, they have come to realize the seriousness of this matter better than any other group of field students, including even the geographers and geologists. We may confidently hope that this volume will do much to assist in this important movement, particularly toward educating public officials. Ecologists and geographers can render an excellent public service by keeping themselves personally informed on these matters and of passing on to the public uncensored dependable information as to actual conditions.

Charles C. Adams

Paleogeography of Northwestern Peru

E. W. Berry. **Petrified Fruits and Seeds from Oligocene of Peru.** Ills. *Pan-American Geologist*, Vol. 47, 1927, pp. 121–132.

From a study of fossil fruits and seeds in northwestern Peru Professor Berry concludes that the plants that produced them grew in humid tropical lowlands at a time when the Andes to the east were sufficiently low to permit the moisture-bearing trade winds to blow with little interruption right across the present Andean region to the Pacific. He further concludes that the Humboldt Current did not wash the shores of northwestern Peru at that time and thus did not exercise a baneful effect upon the climate of the land.

The additional evidence which the paper conveys of the low stand of the Central Andean region in middle and early Tertiary times is most welcome. It supports the conclusions based on physiographic and stratigraphic grounds and referred to repeatedly in earlier volumes of the *Geographical Review*. Berry's conclusions may be modified in time when more is known of the swing of the doldrums and the change in the outer limits of the tropical rainfall belts, for the region in question lies not in the midst of the west-coast desert of South America but close to its northern border where a southerly shifting of the edge of the rainfall belt by a very small amount would supply the humid conditions required by the plant forms described by him. Not only would this account for the humidity but it would also explain the greater rainfall despite the supposition that the Humboldt Current flowed in its present position Under Berry's hypothesis we should still be obliged to account for rainfall derived from the trade winds when they reached the lowland coast. At whatever level the Andes of this region may have stood in the Oligocene period, they were at least higher than the coastal region, and the trade winds could hardly have precipitated their moisture under the assumed conditions of relief unless the southern edge of the central belt of tropical rains were moved southward over the region in which the fossil fruits and seeds were found. The meteorology of the case is not satisfied simply by having the mountains so low that the trade winds could cross them.

A Study in West Indian Physiography

H. A. Meyerhoff. **The Physiography of the Virgin Islands, Culebra and Vieques.** Maps, ills. *Scientific Survey of Porto Rico and the Virgin Islands*, Vol. 4, Part I, pp. 71–141, N. Y. Acad. of Sci., 1926.

In this paper there are given the results of field studies in 1923, 1924, and 1925 in continuation of the scientific survey of Porto Rico (and certain islands to the eastward) by the New York Academy of Sciences. The present paper is concerned chiefly with the physiographic aspects of the Virgin Islands. Briefly stated, the physiographic history is recorded in an oldland composed of a complex mass of folded and stratified surface volcanics, thin sediments, and underwater volcanic instrusions together with other detailed structural features. Upon the complex mountainous relief thus formed, erosion cut the surface to an imperfect peneplain now best seen on the fairly accordant summit levels of the upland of St. John Island a thousand feet above sea level. There ensued a first cycle of erosion, interrupted by 700 or 750 feet of uplift, and a second cycle which reduced all but the central cores of the larger islands to a late mature or old stage of dissection. Again the streams were rejuvenated by about 500 feet of uplift. There followed slow submergence and the deposition of coastal-plain deposits on the lowland areas formed during the preceding cycle of erosion. These deposits were uplifted and all but cut to pieces. In a second submergence the dissected coastal plain was drowned, leaving only a few Tertiary ridges and cuestas above sea level. These physiographic features, already complex, were made more so by the growth of barrier reefs around portions of the margin of the submarine platform, the development of local fringing reefs, and the irregular accumulation of deposits here and there upon the surface of the platform. A final submergence of five or six fathoms has left the shore lines of the islands with drowned topographic features.

The author gives special attention to the physiographic history of the submarine platform about the islands, and this part of his paper represents an important contribution. He takes issue with both Vaughan and Daly as to the validity of their interpretations. Vaughan believes that a graded wave-cut terrace can be formed rapidly to depths of ten fathoms in soft materials and that sea level was lowered some twenty fathoms during the maximum glaciation of the Pleistocene epoch at which level wave-cut platforms were formed that were submerged by the later rise of the water. Daly ascribes similar platforms to marine planation at a low level when ice caps had withdrawn a large quantity of water from the ocean. By a detailed study of the relief of the platforms and the structural geology and physiography of their inner border the author here concludes that the entire submarine platform is to be explained by a complex physiographic history which he has traced and whose stages he has carefully identified and dated rather than by wave action during the episode of glaciation. It is of interest to note that his conclusions are in the main like those of Professor W. M. Davis in "The Lesser Antilles," published by this Society in 1926. This is of special interest because the two authors worked independently and published their results independently, Meyerhoff's study having been completed before Professor Davis' book was known to him. The details of the study are too complicated to present even in outline. The whole study is of the first importance in the physiography of the West Indies.

The Government Study of Rubber Production

J. C. Treadwell, C. R. Hill, and H. H. Bennett. **Possibilities for Para Rubber Production in Northern Tropical America.** xii and 375 pp.; maps, diagrs., ills., bibliogr. *U. S. Dept. of Commerce, Trade Promotion Ser. No. 40,* Washington, 1926. 65 cents. 9 x 6 inches.

Earlier reports of the Crude Rubber Survey of the U. S. Department of Commerce have dealt with the Middle East, the Philippines, the Amazon Valley, and Africa. The present volume on Tropical North America is on the same plan as its predecessors (see *Geogr. Rev.*, Vol. 16, 1926, pp. 162–164 and 491–493). A general discussion is followed by detail studies of the several countries or regions: physical and economic factors are taken up, frequent comparisons being made with the known conditions in the Middle East.

For a belt ten degrees either side of the equator an altitude of 1500 feet is considered as the upper limit of economic cultivation of Para rubber. In Uganda rubber is grown on the equator to 4000 feet, but other factors are exceptionally favorable; and even so the tree is considerably slower in maturing. A marked dry season is unfavorable, hence the Pacific coast of Central America is ruled out. Areas the commission considers physically suitable for plantations are indicated on a series of maps—in some instances soil maps are also given. Starting with southern Tabasco and northern Chiapas is a belt running into northwestern Guatemala; a coast strip in British Honduras and about the gulf of Honduras; small coast patches in Honduras; a belt in the interior and southeast of Nicaragua, which attains a considerable width in the San Juan plain of Costa Rica; thence a coast strip through Panama broadening about the Canal Zone. Airplane reconnaissance by the army aviators of the Canal Zone in 1924 suggests possible areas in the "almost inaccessible" basins of the upper Chucunaque and upper Bayano. On the Pacific coast the first promising region appears in the Tuyra valley. In Colombia a narrow coast strip is favorable, and also the valleys of the San Juan and Atrato and, at appropriate altitudes, of the Magdalena; in Venezuela the difficultly accessible upper drainage basin of the Orinoco and Negro and some coast patches; a coast belt in the Guianas; and small areas in Haiti and Trinidad.

Altogether, over 6,000,000 acres in tropical North America are estimated to be physically suitable for commercial rubber. A fair proportion of this area has transportation facilities to the seaboard and ports within eight days' sailing time of the United States. Land costs are generally low, but scarcity of labor is a handicap—in fact the most serious problem to be confronted.

BOUNDARIES OF THE UNITED STATES

J. T. FARIS. **The Romance of the Boundaries.** xvi and 331 pp.; maps, ills., bibliogr., index. Harper & Brothers, New York and London, 1926. $6.00. 9 x 6 inches.

The title of this book suggests that it was written with the intention of popularizing the history of many of our national boundaries and some of our state limits. Doubtless it will accomplish its purpose, for it is written in a sprightly style, is profusely illustrated, and is printed in large, clear type. It is based for the most part on monographs, government documents, and the collections of local historical societies; and the author seems to have been discriminating in his selection of material. To the serious reader, however, the absence of footnotes and the peculiarity of the bibliography at the end of the volume are grave drawbacks. For instance, when he is told that a certain writer says so and so, he would appreciate a citation of the book or article in which the statement may be found. But there is no footnote. And if he turns to the bibliography he receives little enlightenment there, unless he is lucky enough to guess the title of the work in which it appeared; for instead of listing the works under the names of their authors, this bibliography catalogues the titles alphabetically and forces the investigator to hunt through the list since his only clue is the name of the writer. It is not difficult to understand a publisher's injunction against footnotes in a book designed for popular consumption, but there seems to be no satisfactory explanation for so unserviceable a bibliography.

Although the narrative is almost always interesting, the seeker for information is sometimes exasperated by not being given a definite description of the boundary which was finally established after years of border warfare or of protracted litigation. In the case of the northeastern boundary, for instance, the ultimate determination by Webster and Lord Ashburton is dismissed with the statement that "a satisfactory line was decided on. This line gave to the United States nearly a thousand square miles less than the award made by the King of the Netherlands eleven years before." There is a map, to be sure, but it does not face the text; in fact, it is placed in the next chapter. Likewise in the case of the southwestern boundary the Gadsden Purchase is not even mentioned. Probably the general reader will not notice the omission, so engaging are the pages that recount the introduction of camels as a means of transportation across the American desert. But even the halfway student will be disappointed not to learn the historical background of that slice of territory which was added to our national domain a few years after the ratification of the Treaty of Guadalupe-Hidalgo.

In its details this book is less free from error than the average of its kind. The wearisome process of verifying dates and the spelling of names takes time and energy which every writer begrudges, and it seems probable that Dr. Faris delegated this task to a careless assistant. Though none of the many slips may be seriously misleading, the following examples will suggest how the reader inevitably gets the impression of slipshod workmanship. On page 76 "President" Washington in 1783 is spoken of, though Washington did not become president of the United States until 1789. On the same page General Haldimand's name appears as "Haldeman," and is so indexed. On page 89 in a single paragraph "the parallel of fifty-five degrees" is given where the author presumably intended forty-five degrees, the American Geographical Society is spoken of as the "American Geographic Society," and Hudson Bay as "Hudson's Bay." On page 181 (line 3) "King James" appears where "Charles" would be correct. On page 187 every New England reader will suspect that "Roger Walcott" should be "Roger Wolcott," and on page 236 the spelling of Lawrence Washington's first name is changed to "Laurence." On page 235 the date of the battle at Bushy Run is a year out of the way; and so it goes, even to page 286 where "the Ordinance of 1782" would look better as "the Ordinance of 1787." Perhaps some of these irritating inaccuracies should be attributed to careless proof reading; but, even so, many errors would remain which it is fairly safe to assume belong to the author.

Boundaries are interesting, and the present-day passion for old-time maps is daily increasing the number of persons whose curiosity is piqued by parallels and quirks and jogs. Dr. Faris's book is unique and timely, but its enduring value would have been doubled if the author had subjected the text to careful verification; and, like most books, it would probably have been more finished from the literary point of view if it had been allowed to season for a few months before it went to the publisher.

LAWRENCE S. MAYO

AMERICAN IMMIGRATION

G. M. STEPHENSON. **A History of American Immigration 1820–1924.** vi and 316 pp.; bibliogr., index. Ginn & Co., Boston, New York. 1926. $2.40. 8 x 5½ inches.

HARRY JEROME. **Migration and Business Cycles.** 256 pp.; diagrs., index. (Publs. Natl. Bur. of Econ. Research, Inc., No. 9). New York, 1926. 9 x 6½ inches.

Professor Stephenson divides his main text into three parts. In the first he deals with the European background of the immigration movement, in the second with the immigrants in America, and in the third—a section of only twenty-five pages—with Oriental immigration. A fourth section presents a rather extensive classified bibliography.

The first part takes up certain of the leading immigrant peoples and discusses some of the important conditions, particularly of a social or economic character, that predisposed them to sever home ties and seek their destiny in a new land. The author very rightly considers that the events which are significant in this connection are not the political, dynastic, or even military affairs that bulk so largely in the pages of most histories, but the intimate, routine, homely conditions that affect the standard of living, happiness, and general well-being of the common people. For treatment in this manner he has selected the people of the United Kingdom, the Scandinavians, the Germans, the Dutch, the Italians, the Jews, and the Slavs. In the short space allotted, treatment is of necessity somewhat sketchy. The result is a handy condensation of the more obvious factors in emigration, but little that is particularly new.

The second part is devoted primarily to the legal and political aspects of the immigration problem in this country. The treatment of the growth of the immigration law is commonplace. In his discussion of the rôle of the immigrant in politics and of the political reaction of Americans to immigration, the author is at his best, presenting a considerable amount of new and valuable material. The section on Oriental immigration reviews the standard material on the Chinese and Japanese, ignoring entirely the Hindu question, which at one time loomed rather threateningly on the horizon, and displaying no particular penetration into fundamentals.

Mr. Jerome's book is devoted entirely to a single aspect of the great immigration problem, the relation existing between migration and the periodic fluctuations in business that are so familiar in the countries of western civilization. It is crammed with detailed facts, marshaled in statistical tables and graphs and providing a convenient and dependable magazine of information for any one who wishes to get at the heart of this important matter.

The questions that Mr. Jerome sets himself to answer, simply stated, are: What is the factual relation between fluctuations in immigration and fluctuations in business? How are these fluctuations affected by considerations of sex, race, country of origin, etc.? Are conditions in the United States or in the countries of source more influential in determining the fluctuations in migration? What is the economic significance of the ascertained tendencies?

After a preliminary chapter in which he presents as a background the significant aspects of the migration movement to this country, Mr. Jerome sets up the indices by which he proposes to judge the employment conditions in the United States. These include, for different periods, imports of merchandise, pig iron production, factory employment, and various short-period indices of employment conditions. Of these, pig iron production is regarded as the most significant single index.

Taking first the period before 1890, and particularly that succeeding the Civil War, it appears that the cyclical fluctuations in immigration are a reflex of industrial conditions in the United States, with a lag of from two to four quarters of a year in the early part of the period and a shorter lag in the latter part. The data of the next quarter century, that before the World War, confirm this conclusion. It is quite clear that immigration, particularly of males, responds to employment conditions in the United States usually within a year, while emigration from this country shows a corresponding effect. Consequently, net immigration is peculiarly sensitive to American economic conditions. In the war period and the post-war period various non-economic factors are so influential that the economic relations are obscured, though not wholly concealed.

Turning to a more detailed consideration of various elements in the immigration stream, Mr. Jerome finds that male immigrants are more susceptible to economic influence than female, that true immigrants and emigrants are more responsive than the more transitory types, and that unskilled workers are more sensitive than skilled and professional types. Next, he demonstrates that it is conditions in this country, rather than in the countries of origin, that determine the migrational fluctuations; and he shows very pertinently how this produces unfavorable consequences in the latter if, as is usually the case, industrial depression affects them at the same time as the United States. This section closes with a consideration of seasonal fluctuations.

The final section is the only disappointing portion of the book. So much has been said, pro and con, as to the beneficial effect of migrational fluctuations in relieving periods of unemployment in this country and promoting business expansion at the peak, that a critical and detailed consideration of the evidence in the case would be welcome. Mr. Jerome does, indeed, state his conclusion, which is entirely in harmony with the most reasonable interpretation of the data, that, instead of being a mitigating factor in industrial depressions, immigration tends to make the crises more acute by fostering a feverish and uncontrolled expansion of business in boom times. But he does not give this, which is by far the most practical application of his study, the inclusive consideration that it merits.

On the whole, however, this book represents a most useful type of immigration research and will hold a permanent place in the literature of the subject.

Henry Pratt Fairchild

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GEOGRAPHICAL REVIEW

17/4

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1927

OUR CONTRIBUTORS

Professor Goldthwait is head of the department of geology at Dartmouth College and geologist of the New Hampshire State Highway Department. His work in the latter capacity has led to the study of various aspects of the human geography of the region in which the state lies. He is well known as an authority on the physiography of New England and eastern Canada, his numerous writings including two excellent handbooks, "Physiography of Nova Scotia" (1925) and "Geology of New Hampshire" (1925).

Mr. Rudolph is a civil engineer who has since 1922 been associated with the Chile Exploration Company at Chuquicamata. He has carried out extensive explorations in this part of the Atacama Desert.

The Rev. Mr. Beynon is pastor of the Centenary Methodist Church, Detroit, the membership and services of which are entirely Hungarian. He is of Irish ancestry and was an officer in the Indian Army during the World War, and his ethnological interests embrace the Celtic people and the peoples of India as well as the Hungarians.

Mr. Coulter, formerly instructor in geography in the University of Chicago, has this summer been in charge of geography at the University of Washington, Seattle. To the *Geographical Review* he contributed "A Dot Map of the Distribution of Population in Japan" (Vol. 16, 1926).

Dr. Dixey is government geologist to the Nyasaland Protectorate. He previously held a similar position in Sierra Leone. In both countries his work has included physiographic and economic investigations. "The Physiography of Sierra Leone" appeared in the *Geographical Journal*, Vol. 60, 1922.

Dr. Palmer is professor of geology at the University of Hawaii, Honolulu. He has worked on water supply problems.

Mr. Woodworth is instructor in botany and tutor in biology at Harvard University.

Sir Patrick McGrath is President of the Legislative Council of Newfoundland. He has long been associated with the affairs of the Colony, among other services assisting in the preparation of the Colony's case regarding French and American fishery disputes. For thirty years he has acted as Newfoundland correspondent of the *London Times.*

Dr. Marbut, in charge of soil survey of the Bureau of Soils, U. S. Department of Agriculture, has a special interest in the geography of soils. He is co-author of "The Vegetation and Soils of Africa," *Amer. Geogr. Soc. Research Ser. No. 13*, 1923. As President of the Association of American Geographers for 1924 he spoke on "The Rise, Decline, and Revival of Malthusianism in Relation to Geography and Character of Soils" (*Annals*, March, 1925). To the *Geographical Review* he contributed "The Soils of the Amazon Basin in Relation to Agricultural Possibilities" (Vol. 16, 1926).

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The Vegetation and Soils of Africa. By H. L. SHANTZ and C. F. MARBUT. With a section on land classification by the joint authors and a note on a rainfall map of Africa by J. B. KINCER. With 1 text map, 49 photographs, and a separate case of two maps (in color) 1:10,000,000, each with inset, 1:25,000,000, showing vegetation (on inset: soils) and land classification (on inset: annual rainfall). x and 263 pp. *Research Series No. 13*, 1923. $5.00.

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Geography of the Central Andes: A Handbook to Accompany the La Paz Sheet of the Map of South America on the Millionth Scale. By ALAN G. OGILVIE. With an introduction by ISAIAH BOWMAN. With 2 maps in color and 41 diagrams and photographs. 240 pp. *Map of Hispanic America, Publication No. 1*, 1922. $3.00 (if purchased with the La Paz map, $2.00).

Map of Hispanic America, 1:1,000,000 [15.78 miles to 1 inch], Provisional Edition, North H-11, **Baja California Norte**; North G-12, **Baja California Sur**; North F-16, **Yucatán**; North F-18, **Santiago de Cuba**; North E-18, **Kingston-Port-au-Prince**; North E-19, **Santo Domingo-San Juan**; North E-20, **Lesser Antilles North**; North D-20, **Lesser Antilles South**; North C-17, **Panamá**; North A-17, **Río Mira-Islas Galápagos**; South C-19, **Acre**; South D-19, **Puno-Río Beni**; South E-19, **La Paz**; South E-20, **Sucre**; South F-19, **Iquique**; South F-20, **Río Pilcomayo**; South G-19, **Atacama**; South I-18, **Canquenes y Islas Esporádicas**; South L-18, **Península de Tai-Tao**; South M-18, **Isla Wellington-Lago Argentino.** $2.00 each sheet.

Map of Hispanic America, 1:6,000,000 [about 100 miles to 1 inch], compiled from nearly 250 sources and showing railways, drainage, international and administrative boundaries, and towns in graded sequence down to those with a population of 4000. Produced in black in three sheets—measurements of 2 (to border) are 34 x 28 inches, and of the third 32¼ x 30 inches. 1922. $5.00.

Mapa de la Republica de Panama, 1:500,000 [7.89 miles to 1 inch] compiled from over 100 original surveys, many of them unpublished. Printed in five colors. Follows in general the scheme of the International Map of the World on the Millionth Scale, but hypsometric tints have been omitted and the provinces shown in color instead. Accepted as official map by the government of Panama. 33 x 63 inches. 1926. $3.00.

Separate Maps published in the *Geographical Review* and the *Bulletin of the American Geographical Society*, the majority in color. 25 cents each. A list will be sent upon request.

THE
GEOGRAPHICAL REVIEW

VOL. XVII OCTOBER, 1927 NO. 4

A TOWN THAT HAS GONE DOWNHILL

James Walter Goldthwait
Dartmouth College

[With separate map, Pl. IV, facing p. 552]

"AGRICULTURE is, and always will be, the chief business of the people of New-Hampshire, if they attend to their true interest." So wrote Jeremy Belknap, first historian of the state, in 1792.[1] And for thirty years, at least, his words were echoed by authors of successive "gazetteers." Now, for almost a century deserted farms in New Hampshire have been growing up to blueberry pasture, woodland, and forest. The sturdy population that was once evenly distributed over thousands of square miles of the stony upland has slowly and steadily moved down from the hilltops, emigrating to distant places, or lingering yet awhile in the valleys. Large tracts of land have been abandoned or have become the summer homes and playgrounds of well-to-do vacation seekers from the cities.

The downhill movement, particularly, came to my attention a few years ago, while making a topographic map of the township of Lyme. Since the eastern half of this township is deserted country with scarcely an occupied house and very few traveled roads, it became a matter of practical interest to locate all such landmarks as abandoned roads and stone walls, cellar holes, orchards, and other signs of former culture. As this work progressed, comparison with the earliest detailed map then known to me—the map of Grafton County by Walling, in 1860[2]—on which every occupied house is shown with name of occupant, disclosed the fact that certain cellar holes mark sites of houses that were abandoned before 1860. An

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[1] Jeremy Belknap: The History of New Hampshire, 3 vols., Boston, 1791–1792; reference in Vol. 3, p. 142.

[2] H. F. Walling: Topographical Map of Grafton County, N. H. Scale 1:70,000. New York, 1860.

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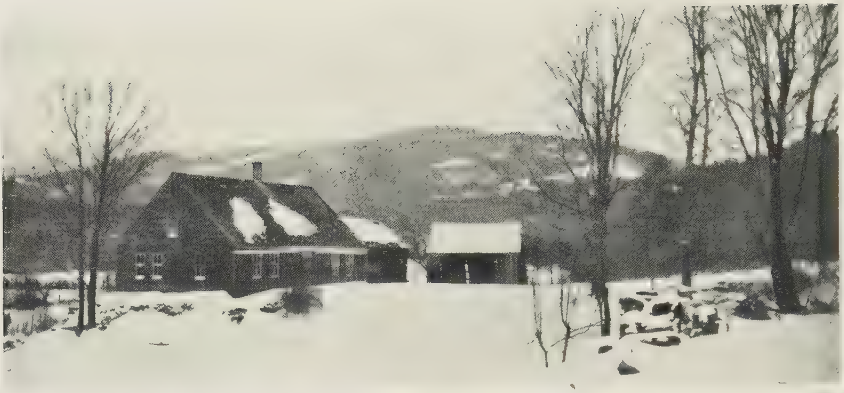

FIG. 1

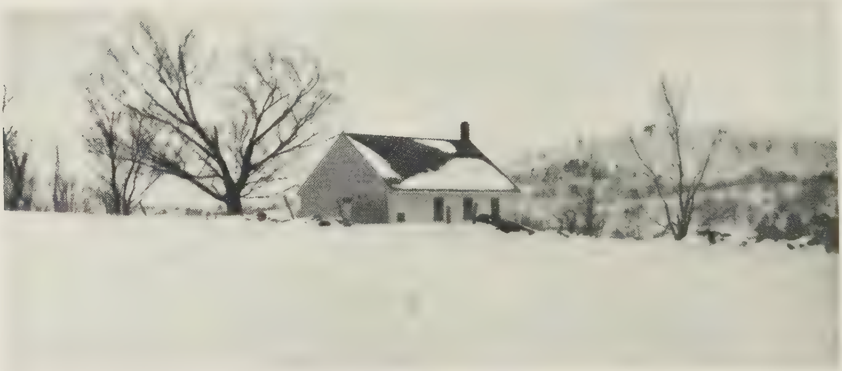

FIG. 2

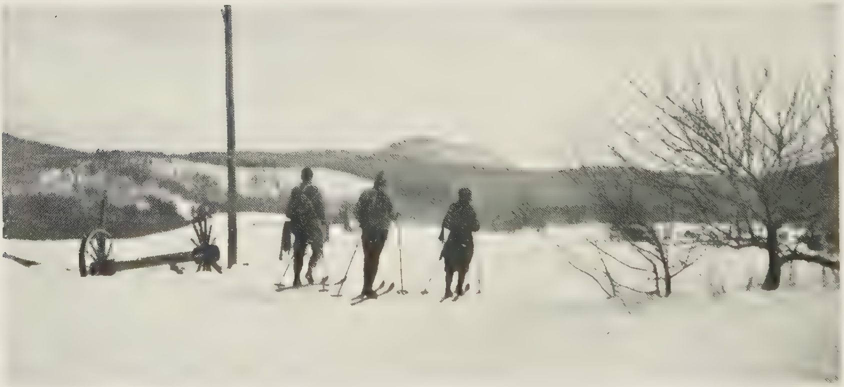

FIG. 3

FIG. 1—An unoccupied house on the Dorchester road (see Pl. IV, facing p. 552).
FIG. 2—Deserted schoolhouse of the Acorn Hill district.
FIG. 3—On the road to Hardscrabble. Smart's Mountain in the distance.

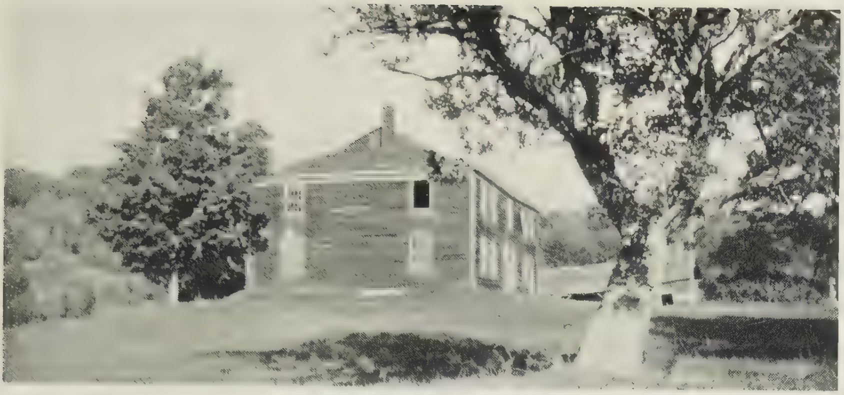

FIG. 4

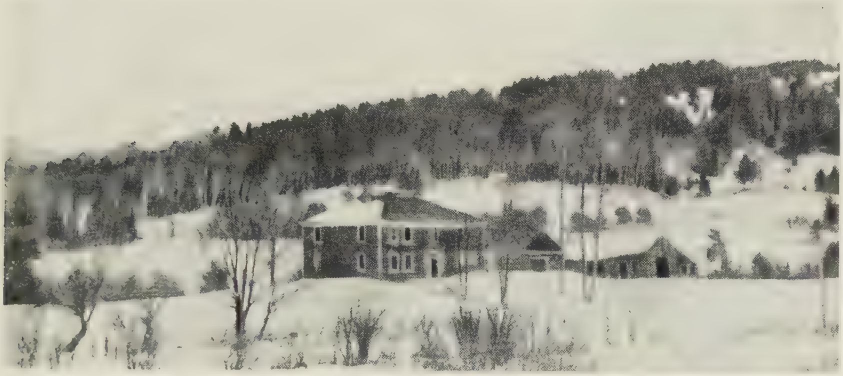

FIG. 5

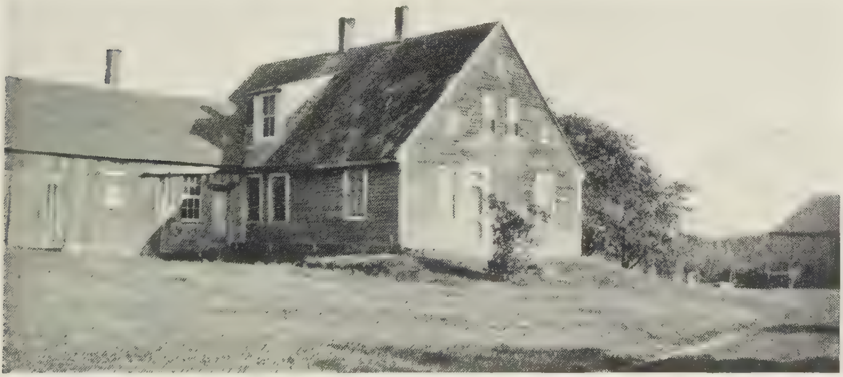

FIG. 6

FIGS. 4 and 5—The Colonel Selah Beal house, falling to ruin on the Dorchester road under Smart's Mountain.

FIG. 6—An old farmhouse only recently left unoccupied.

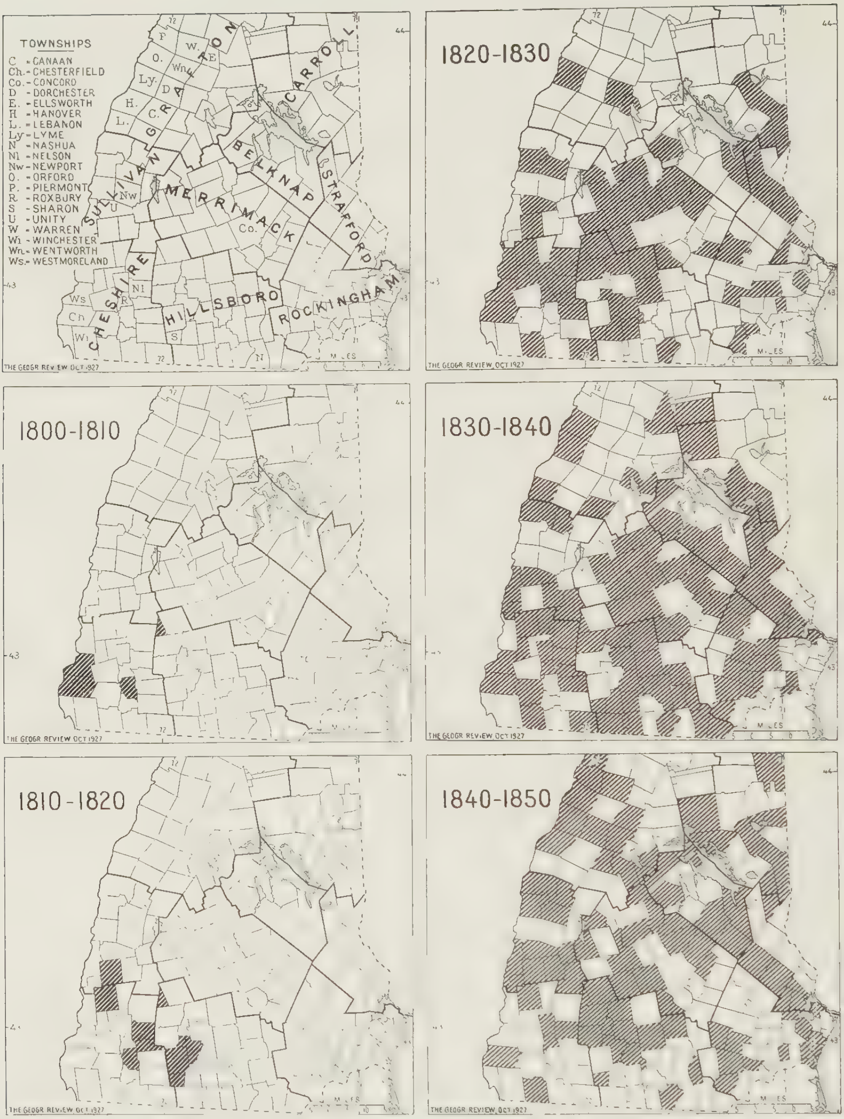

FIG. 7—Maps of central and southern New Hampshire showing losses in population by townships for each decade in the first half of last century. A key map names the counties and the townships referred to in the text. Scale 1: 3,250,000.

effort was made, therefore, to discover as many of these pre-1860 cellar holes as possible and thus to obtain data for a map that would show the extent of settlement of the township at the time of its maximum population, which was about 1830. While the results are by no means complete, because many cellar holes or house sites have been erased or lie hidden in a wilderness of forest, they form a basis for comparison with detailed maps of three later dates—the Walling map of 1860, the map of Lyme in Hurd's Atlas of New Hampshire in 1892,[3] and the new map made in 1925. With these four maps it is possible to study the shift of population through the township, house by house, in three successive 30-year periods, or generations: 1830–1860, 1860–1892, and 1892–1925.

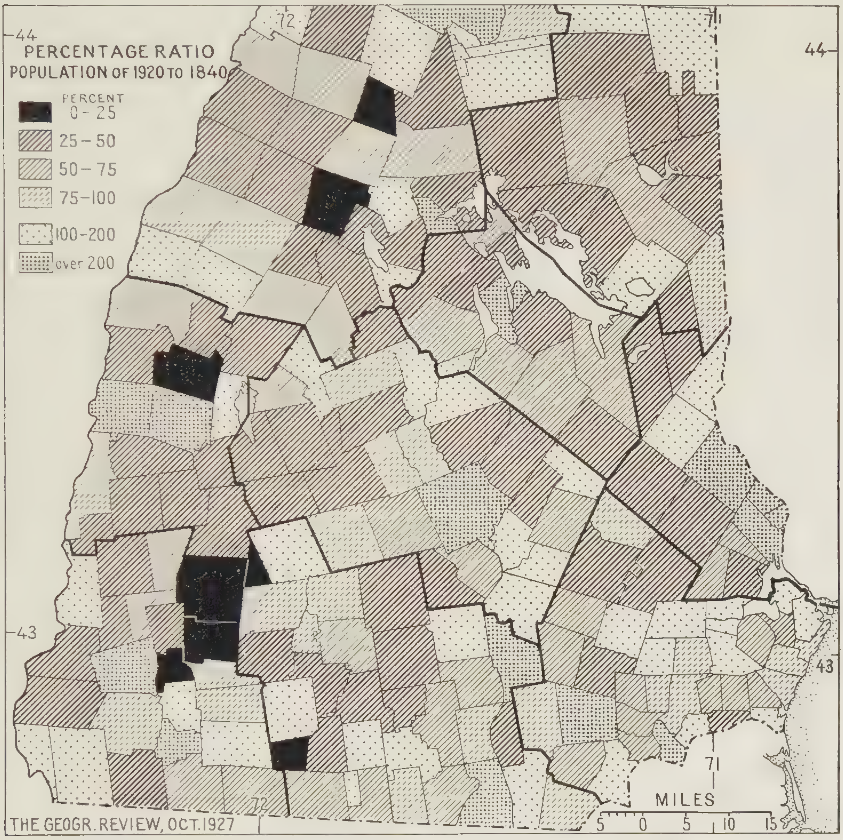

FIG. 8—Map of central and southern New Hampshire showing percentage of losses and gains in population by townships for the period 1840 to 1920. Scale 1: 1,400,000.

In order more fully to appreciate the movement of which this local flowage of humanity is a part, its history will first be briefly sketched.

THE INCOMING TIDE OF THE EIGHTEENTH CENTURY

The interior of New Hampshire, and particularly the upper portion of the Connecticut valley, to which attention is to be drawn, was settled mainly by farmers from Connecticut just after the close of the French and Indian wars. According to Belknap the number of people in this state doubled in less than 19 years, before the year 1790, notwithstanding the fact that seven of these years were years of war.

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[3] D. H. Hurd & Co.: Town and City Atlas of the State of New Hampshire. Map of Lyme township on p. 194. Scale approximately 1¼ inches to the mile. Boston, 1892.

> Where land is cheap, and the means of subsistence may be acquired in such plenty, and in so short a time as is evidently the case in our new plantations, encouragement is given to early marriage. A young man who has cleared a piece of land, and built a hut for his present accommodation, soon begins to experience the truth of that old adage "It is not good for man to be alone." Having a prospect of increasing his substance by labour, which he knows himself able to perform, he attaches himself to a female earlier than prudence would dictate if he had not such a prospect. Nor are the young females of the country averse to a settlement in the new plantations; where, after the second year's labour, by which the land is brought into pasture, there is a necessity for beginning the work of a dairy; an employment which always falls to their lot, and is an object of their ambition, as well as interest.[4]

Abundant evidence remains of the vigor and hopefulness of these pioneers. With their ox teams they cleared incredible areas of hill country. Trees were chopped down or burned, stumps were uprooted, field stone was dragged off to make walls along every road and around every pasture; and crops sprang up on every sunny hillside. Wood lots were left only on north slopes and in tracts absolutely too rough for cultivation. These farmers were bold in their choice of land to occupy and clear. They usually preferred the hillsides to the flat or terraced valleys, because the hills were better drained and because their soil, though more stony, appeared less liable to become exhausted with use than the lighter loam of the valleys. There was no lack of cordwood to warm the houses through the long cold winter; and lumber was to be had without limit, for the sawing. Sawmills and gristmills were built as soon as log huts, and frame houses quickly followed. These were simple but substantial.

> Land being easily obtained, and labour of every kind being familiar, there is great encouragement to population. A good husbandman, with the savings of a few years, can purchase new land enough to give his elder sons a settlement, and assist them in clearing a lot and building a hut; after which they soon learn to support themselves. The homestead is generally given to the youngest son, who provides for his parents, when age or infirmity incapacitates them for labour. An unmarried man of thirty years old is rarely to be found in our country towns. The women are grandmothers at forty, and it is not uncommon for a mother and a daughter to have each a child at the breast, at the same time; for a father, son and grandson to be at work together in the same field. Thus population and cultivation proceed together, and a vigorous race of inhabitants grows up, on a soil, which labor vies with nature to render productive.[5]

Every house had a cellar walled with boulders collected from off the place; and doorsteps and hearthstones were carefully selected from flat-splitting blocks or ledges in the neighborhood. Apple orchards, at first wholly for cider but later for "eating apples," were planted

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[4] Belknap, *op. cit.*, Vol. 3, pp. 237–238.

[5] *Ibid.*, pp. 260–261.

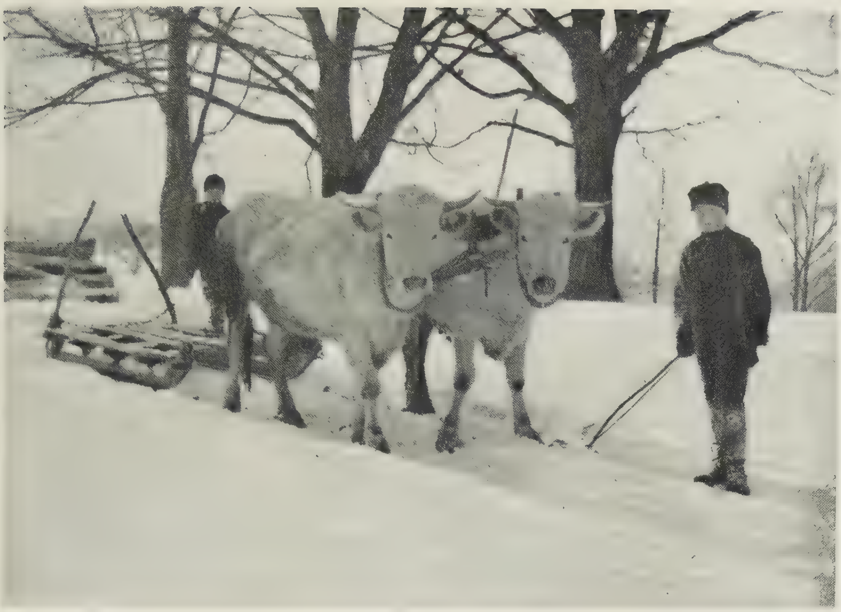

FIG. 9

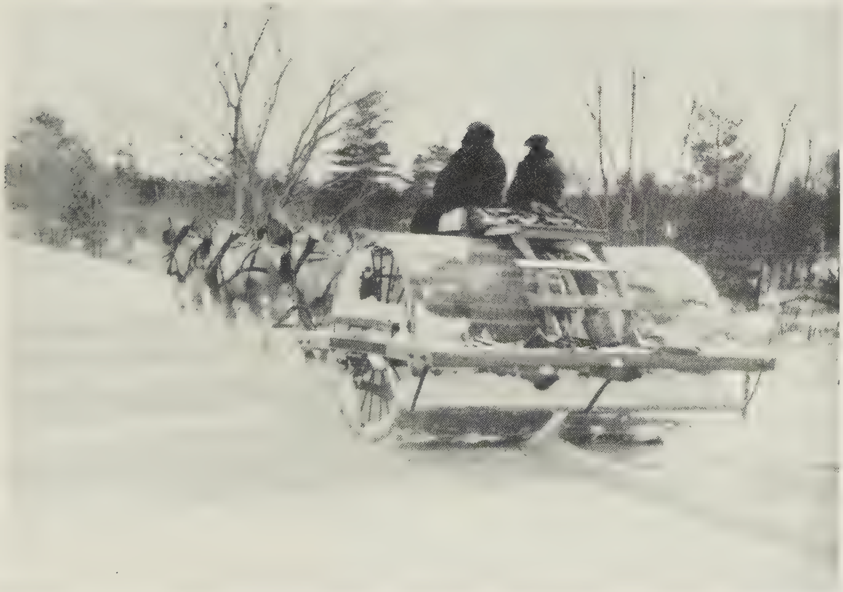

FIG. 10

FIG. 9—The ox team was an essential of the pioneer's equipment.
FIG. 10—Rolling a town road after a snowstorm.

around every homestead. Sugar maple orchards were given much care and are still producing quantities of fine syrup.

Altitude and distance from the village seem to have counted little with these settlers. What did it matter if there was a five or six mile journey across the township, in days when the vehicle was an oxcart and when any one in a hurry went on horseback? There was little occasion to go farther than the nearest village store or blacksmith shop. Each neighborhood was practically self-supporting. A journey to a distant city like Boston or Hartford was an unusual event and took days.

One tramping over these deserted hill farms now is struck with the thought that loneliness was somehow at the root of the process of abandonment. But a consideration of the map shows little basis for that idea. Houses were not far apart. However lonely the country has become, that must not be counted among the original reasons for its abandonment, but rather as a consequence of it. Moreover, life for these people was too earnest to be dull. "The people of New-Hampshire, in general, are industrious, and allow themselves very little time for diversion. One who indulges himself in idleness and play, is stigmatized according to his demerit."[6]

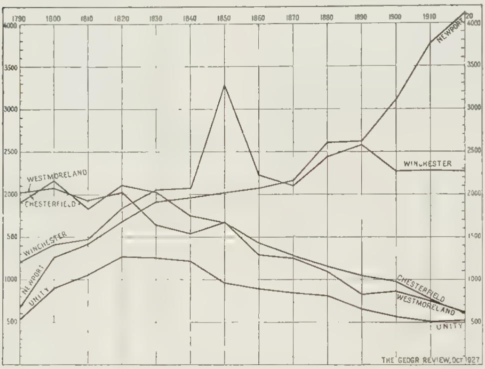

FIG. 11—Graph showing population of Newport and Unity townships and of Winchester, Chesterfield, and Westmoreland townships from 1790 to 1920.

THE TURNING OF THE TIDE TOWARD THE WEST

Early in the nineteenth century the tide of population stopped rising and began at once to subside. By 1840 it was falling generally throughout the state. On the maps in Figure 7 can be seen the way in which this condition of ebb tide spread northward across the upland between 1800 and 1840.

No doubt the country had been somewhat overpopulated, as a result of the processes reviewed by Belknap; for these hill farms were not all productive, and they became less so as successive crops were harvested and fields were not sufficiently fertilized. The discovery of that discouraging fact must have come at an early date, although one finds scarcely an admission of it for several decades in the optimistic gazetteers of the time. It is not until 1860 that we read that "the

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[6] *Ibid.*, pp. 262–263.

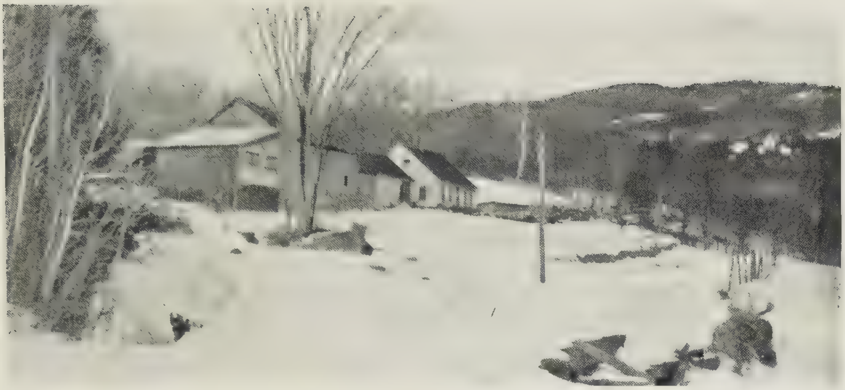

FIG. 13

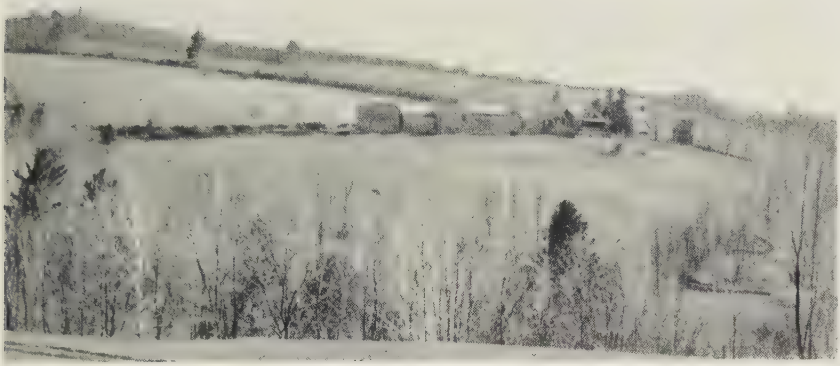

FIG. 14

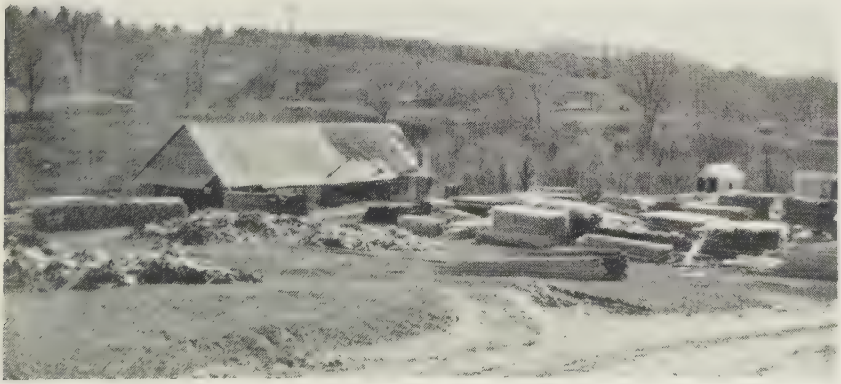

FIG. 15

FIG. 13—The last occupied house on the Dorchester road.
FIG. 14—A connected "set o' buildings," still occupied, on the side of Plott Hill.
FIG. 15—An old sawmill that still does a small business. Lyme Center.

principal occupation of the people is in subduing a hard, silicious surface, and extorting from its reluctant lap the bread of toil."[7] Accounts of extraordinary crops of maize, wheat, barley, oats, and flax are offered, in close proximity to derogatory statements about western farms, which were attracting the New Hampshire farmer as early as 1820 and increasingly for several decades. Hayward's Gazetteer of 1849, after quoting Dr. Jackson, the state geologist, regarding a cornfield on one of the islands of Lake Winnepesaukee, where careful agricultural methods resulted in a yield of 136 bushels to the acre, remarks:

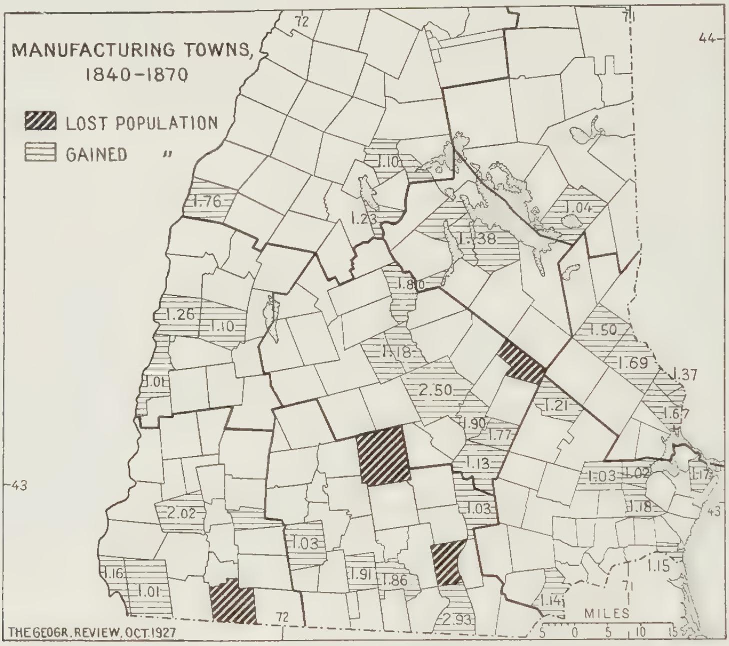

Fig. 12—Map of central and southern New Hampshire showing loss and gain in population in manufacturing townships from 1840 to 1870. The figures give ratio of gain. Scale 1:1,800,000.

> One would suppose that the fertility of the western prairie could offer little temptation to the farmer who might produce such a crop, and remain among his own paternal fields; especially when the contrast is made between the healthiness of a northern climate, in a high, hilly region, pure water flowing plentifully, all facilities for happily training a family; and a country where, indeed, labor is comparatively light, land cheap, and winters lose much of their rigor and length; but fever and ague sap the constitution, and send back the adventurer a lean, sallow invalid for life, or lay him prematurely in the grave.[8]

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[7] A. J. Coolidge and J. B. Mansfield: History and Description of New England: New Hampshire, Boston, 1860, p. 396.

[8] John Hayward: A Gazetteer of New Hampshire, Boston, 1849, p. 22.

While this forbidding picture of the emigrant was being held up to readers of the gazetteer, the state continued to pour out farmers into the west at an alarming rate. Where most of them went is shown in Table I.[9]

The tendency for emigrants to go farther and farther west is seen in a comparison of the columns for 1860 and 1870.

TABLE I—NEW HAMPSHIRE IN ACCOUNT WITH OTHER STATES AND TERRITORIES AS REGARDS NATIVE POPULATION

STATE	DR. 1860	CR. 1860	NET LOSS 1860	NET LOSS 1870
Massachusetts . . .	44,035	19,973	24,062	31,269
New York	12,497	2,045	10,452	6,712
Pennsylvania . . .	1,773	227	1,446	1,545
Ohio	4,111	150	3,961	3,117
Indiana	1,072	28	1,044	979
Michigan	3,482	66	3,416	3,544
Illinois	7,868	104	7,764	8,022
Wisconsin	5,907	85	4,822	4,800
Minnesota	2,387	22	2,365	3,216
Iowa	3,287	18	3,269	5,000
California	2,552	15	2,537	2,653
Total, all States and Territories . . .	125,516	47,328	78,188	80,360

> This account shows that 124,979 persons who were born in New-Hampshire are now [1870] living in other States in the Union; and that 46,282 who were natives of other States, now reside here—showing an emigration against us of 78,697, or a gain [i. e. increase in emigration] from the last decade of 2172, and probably without a parallel in any State or nation, this side of Ireland.[10]

THE MOVEMENT FROM FARM TO FACTORY

The decline in population in New Hampshire was not due simply to emigration following the discovery of better farms in the west. Another strong influence was at work. New Hampshire with the rest of New England was being transformed into an industrial region. This change began in 1800–1810, so slowly as scarcely to be recognized, but gathered strength and speed, so that by the middle of the century it had become a dominant factor.

To get a closer view of the influence of manufacturing in this early period, we may look again at the maps in Figure 7. Westmoreland and Chesterfield, near the southwest corner of the state, on the Connecticut River, were farming towns of large area and favorable situation which had reached a total population of 2000 by the year 1800. Next to them on the southeast is the township of Winchester, similar to them in size and topography, but crossed diagonally by the swift-flowing Ashuelot River. Although it was mainly a farming town, the mill sites along this stream had come into use at the very first. Between 1800 and 1810 Winchester grew in numbers from 1413 to 1478, while Westmoreland fell from 2066 to 1937 and Chesterfield from 2161 to 1839, starting a decline which has continued until the population is now approximately 35 per cent of what it was.

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[9] Based on census statistics taken from A. J. Fogg: The Statistics and Gazetteer of New-Hampshire, Concord, N. H., 1874, p. 451.

[10] *Ibid.*, pp. 451–452.

TABLE II—ECONOMIC CONDITIONS IN NEW HAMPSHIRE IN 1840 AND 1870

	1840	1870
Miles of railway	6	900
Pairs of boots and shoes manufactured	500,000	8,000,000
Cotton goods manufactured	$4,000,000	$30,000,000
Woolen goods manufactured	$800,000	$9,000,000
Total manufactured goods	$13,000,000	$95,000,000
Persons engaged in manufacturing	12,000	46,553
" " " agriculture	78,000	46,573

As the falling wave of population spread northward over New Hampshire, towns like Winchester which had water power came to be oases of prosperity in an otherwise afflicted upland country. The map, which shows losses from 1830 to 1840 in particular, indicates the comparative success and growth of towns along the Merrimack, Contoocook, Ashuelot, and Sugar Rivers. The contrast in the case of Newport and Unity, whose population curves are shown in Figure 11, is the same story in different form.

THE DISTURBING INFLUENCE OF THE RAILWAY

The first railway line to enter New Hampshire came up the Merrimack River in 1838 from Lowell, Mass., to Nashua, ending there within six miles of the border. By 1842 it had been extended up the river to Concord; and before 1850 there were connections northward and northwestward by several routes to the Connecticut valley, where Vermont and New Hampshire vied with each other for the advantages expected to come from rapid transportation. Most of the existing main lines of southern New Hampshire were in operation by 1850; and many branches were built between that date and 1870, linking the smaller towns to the larger by more crooked paths and uneven grades.

In the three decades 1840–1870 the railway was perhaps the strongest single factor affecting life in New Hampshire. Although it might have been expected to encourage farming as well as manufacturing, by putting the farmer within reach of Massachusetts markets, that was not the result. The decline in rural population was not checked but rather intensified. Manufacturing centers grew faster than before. Rising generations of boys and girls felt the urge of the city. The difficulties of earning a livelihood on the small New Hampshire farm became more and more real as the scale of living on the farm rose in response to that of the industrial world. The movement from farm to factory was at last uncontrollable.

The economic transformation of these three decades is shown in Table II. Special attention is called to the last two pairs of figures. While the number of farmers and farm hands fell to about six-tenths the figure of 1840 the number of factory employees rose to almost four times the earlier figure, becoming as large as that of the farming population. Among the contributing factors should be mentioned the introduction of farm machinery which greatly reduced employment on the farm at the time when manufacturing offered abundant opportunity.

The greatest gains were made in the Merrimack valley, where opportunity for power development on a large scale and accessibility to Massachusetts attracted capital; and the cities of Manchester and Nashua, in particular, had phenomenal growth. In several cases industrial growth led to partitioning of old townships into new ones, one mainly industrial and the other agricultural.

The Development of a Summer Migration

The growth of the nation in industry after the seventies, and particularly that of southern New England, brought with it an increasing allotment of time to leisure and recreation. The summer vacation became a vital part of the calendar for hosts of people. Hotels in the White Mountains region grew in number and popularity, and farmhouses began to look for summer boarders. As summer visitors felt the spell of mountains, hills, forest, and lakes, they began to purchase lake-shore lots for camps and cottages, or to buy deserted farms and rehabilitate them. This process is still going on rapidly, after thirty or forty years, without exhausting the supply of desirable places. In fact, there are some townships, like Lyme, in which summer still brings little increase in population. The repairing of the old buildings and clearing up of "the place," though usually without much outlay of money (measured according to city standards), and the occupying of so many farms for even a few months every year have brought employment to a great many year-round inhabitants who act as caretakers, gardeners, painters, and carpenters and furnish fresh vegetables, milk, eggs, and transportation. Country stores that are little more than neighborhood post offices during the winter carry a large and elaborate stock of groceries from late June till mid-September.

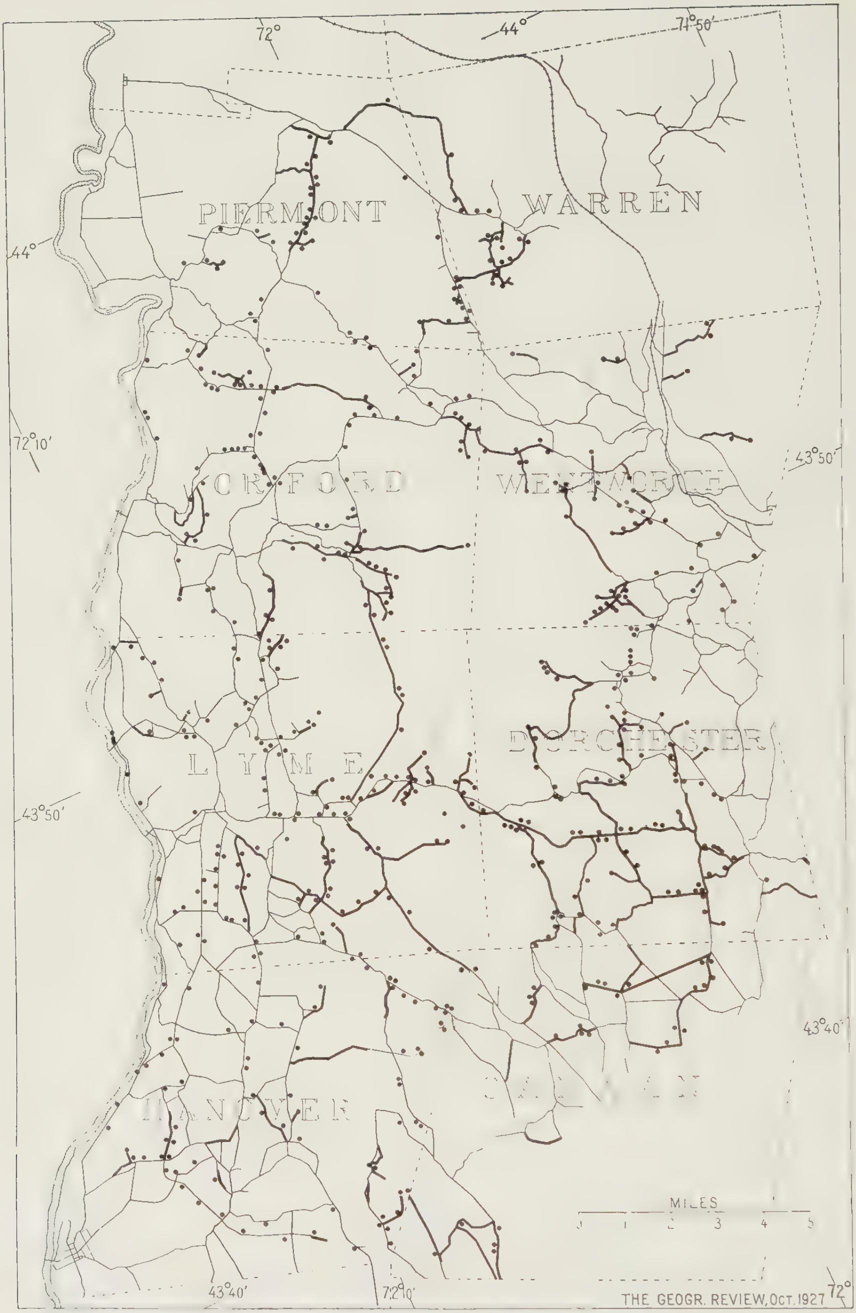

Fig. 16—Map showing the extent of desertion of roads and houses in the region about Lyme, N. H. The dots represent deserted houses, and the heavy lines deserted roads: roads still in use are shown by a light line. On the west the Connecticut River. Compare Figure 17. Scale 1:260,000.

During the last fifteen or twenty years the growth of well organized and advertised boys' camps and girls' camps through the state has added still another opportunity to the native population to increase their earnings. Large state and national forests reserves, chiefly in the central and northern parts of the state, trail-cutting, and the establishment of overnight camps and huts by such organizations as the Appalachian Mountain Club have made mountain climbing comfortable and attractive. The scenic features of New Hampshire have come to be regarded as her most precious resource, and countless acres on which serious-minded pioneer farmers and their ox teams toiled a century ago are now delighting a generation of city dwellers.

The latest aspects of the influence of the recreation movement have been the development of overnight stopping places for automobile tourists, the multiplication of small service stations and refreshment stands along all motor routes, and the selling of vegetables, apples, and other home products at thousands of wayside counters. This business is great in total amount but very widely distributed among the native farming population. It is significant also that summer residents are coming earlier and staying later in the season than formerly; and that efforts of hotel men, railway men, and local merchants to induce people to come up into New Hampshire for mid-winter vacations or holidays are meeting with encouraging response.

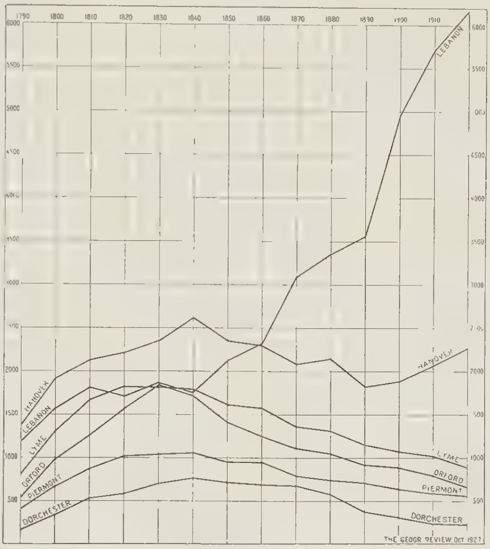

FIG. 17—Graph showing population of Lyme, N. H., and neighboring towns from 1790 to 1920. Compare Figure 16.

FLOOD AND EBB IN THE MIDDLE CONNECTICUT VALLEY

Before looking closely at the town of Lyme we may glance at the block of townships among which Lyme has a central position. The influences reviewed in the foregoing paragraphs have called out differing responses from them, for reasons that will be rather obvious. The map, Figure 16, shows a group of seven towns, namely Hanover, Lyme, Orford, and Piermont along the Connecticut River, and Canaan, Dorchester, and Wentworth adjoining the first four along their eastern borders. These towns were all chartered and settled during the period between 1760 and 1770, with those on the river first to be occupied. On the population curves (Fig. 17) we find Lyme and Orford rising rapidly to a maximum of 1800 population about 1830, then losing strength steadily to 1920, when the population is less than 50 per cent of its old maximum of ninety years ago. Dorchester, high up on the watershed between the Connecticut and Merrimack, has always been a poor town, although, in spite of its handicaps, it was pretty well cleared and farmed by 1840. Since then its population has fallen to 30 per cent of the old figure, and three-quarters of its area has grown up to woodland and forest and contains not a single occupied house. Hunters, fishermen, and campers find here a paradise of deserted roads, overgrown pastures, ruins of old farm buildings, along with plenty of game. Partridges and foxes are more numerous than human beings. Piermont, next township "up-river" from Orford, reached its peak also in 1840, with about 1000 inhabitants and no industry save farming. Its decline has been somewhat less rapid but none the less sure than the others.

The two towns that lie southeast present a marked contrast. Hanover, since its settlement in 1761 the seat of Dartmouth College, shows the usual wave curve of the rural New Hampshire town, with maximum at 2163 in 1840, and steady decline to 1817 in 1890. During all that time the college was small and the township was almost wholly agricultural. Between 1890 and 1900 the rebirth of the college, under a distinguished educator, gave the town new life; and it has risen steadily again to something like its population in the days of profitable agriculture. Even now the land under cultivation (chiefly as dairy farms) reaches farther up the hillsides here than it does in adjoining townships; but the area farmed is only a small part of what was farmed in 1840. The population has gravitated toward the college in the southwestern corner of the town, where it is packed closely into a village precinct.

Lebanon, which lies next southwest of Hanover, on the Connecticut and Mascoma Rivers, has topography and soil as favorable for farming as the surrounding towns, but is far more favorably situated than they for manufacturing. Several really good power sites on the Mascoma River were occupied early, and others have been taken up by manufacturing and power companies. With the coming of the railway in 1847 the town began to gain rapidly and now it is three times the size of its neighbors. Immigration of French Canadians to work in the factories has been considerable; but there has also been a strong draining of the native-born from the farms of the township and those around it. No town in the state, perhaps, offers so good a chance to study in detail the shift from farm to factory.

Lyme: The Township and Its Activities

Like many New Hampshire townships, Lyme is rhomboidal in form and measures six or seven miles on each side. Although in detail its surface is irregular, the broader features are simple and orderly. From the flood lands of the Connecticut River, on its western border, and the somewhat higher terrace of silt that represents the floor of an old glacial lake the upland rises eastward and southeastward over successive ridges and highland areas into a really rugged eastern frontier. Here, at the northeastern corner of the township, Smart's Mountain rises domelike over 3000 feet. To the south, lower hills, yet also fairly rugged and exceeding 2000 feet, break a wooded sky line.

The northeast-southwest trend of the folded metamorphic rocks that pass beneath this township gives to its worn-down surface a strong grain, with ridges and swales parallel to the master feature—the valley of the Connecticut River. But the three streams that drain this township into the Connecticut cross the structure and the ridges squarely, from southeast to northwest. Typical of glaciated New England, these brooks descend by a bewildering series of short rapids, cascades, and still-water stretches, twisting and straightening out as they struggle over ledges or escape around them by cutting through the stony mantle of drift. Midway along the valley of the central stream, Grant's Brook, in the geographic center of the township is the little village of Lyme Center (first called Cook City and then East Lyme), which consists of about twenty houses, a Baptist church, a schoolhouse, a sawmill, and a small but very "general" store. The local post office, as in many a small New England neighborhood, survives in a private house. Two miles down the road, where this valley reaches the upper terrace plains of the Connecticut, is the larger village of Lyme Plain. Two or three stores, a schoolhouse, a large white church of the colonial period, a prosperous village hotel, and a typical old burying ground that looks much too large for the place give distinction to the sides and corners of the village common and indicate that this is certainly the life center of a township.

In the days of its settlement Lyme was reached from the south by road up the Connecticut River, which was passable at least for oxcarts and horseback riders. This old "river road" has never been "thrown up" by the town, but it is so distinctly off the course of modern travel that one may follow it for miles without having to turn out for an automobile. The tourist highway, or "Dartmouth College Road," lies a mile farther in from the river, climbing across low hills from Hanover to Lyme Plain and then descending to the level clay lands of the river valley. This western half of the township is well covered with town roads, in all stages of upkeep or disuse. The eastern half, however, has almost entirely been given over to nature. The road that leads eastward from Lyme Center toward Dorchester is the only traveled road in the area and links loosely together a few small farms, which terminate halfway to the Dorchester line.

While Lyme looks like a rich field in which to study at close range the story of decline of population, there is one serious handicap. All the town records prior to 1873 were destroyed by fire, and it boasts no published contemporary early history. The most interesting and informing account available, by far, is an historical sketch of some thirty-five pages written in 1886 by P. H. A. Claflin, a native of the town, for Child's Gazetteer of Grafton County.[11] This draws richly from the memories of old persons then living, from family Bibles, and from other memoranda. The books of the Selectmen and Tax Assessors since 1873 contain interesting material touching area under cultivation, sheep raising, stock farming, poultry raising, dairying, lumber cutting, etc., and show how rich in interest the books of the earlier periods would be if they were available. But records of the late seventies and eighties after all do little more than corroborate

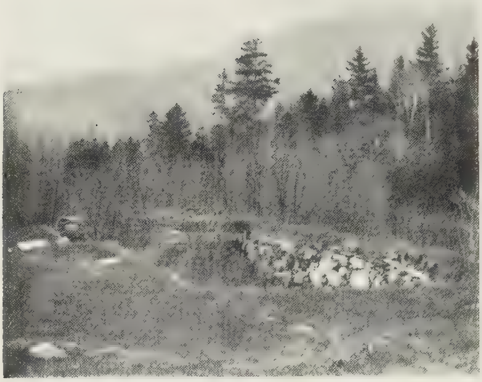

Fig. 18

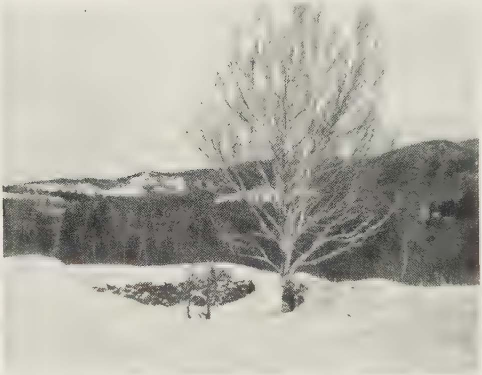

Fig. 19

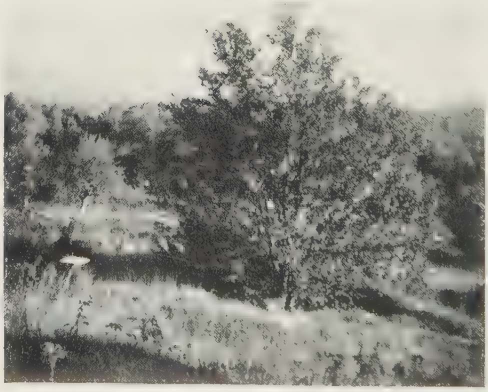

Fig. 20

Fig. 18—Cellar hole on Dorchester road near Smart's Mountain.

Fig. 19—Old cellar hole near Hardscrabble.

Fig. 20—Cellar hole in a clearing near Smart's Mountain. Birches have grown up out of it. Old apple tree back of plane table.

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[11] Hamilton Child: Gazetteer of Grafton County, N. H., 1709–1886, Syracuse, N. Y., 1886. Section on Town of Lyme by P. H. A. Claflin, pp. 517–551.

and make more exact the knowledge that one may get from conversation with well preserved octogenarians of today. Records of the local church, which ranked among the largest of the state for many years are of more interest to the antiquarian than the geographer. A complete study of wills and deeds recorded (at Woodsville, N. H.) by early inhabitants of the township would probably supply much information not elsewhere obtainable; but that has not been attempted.

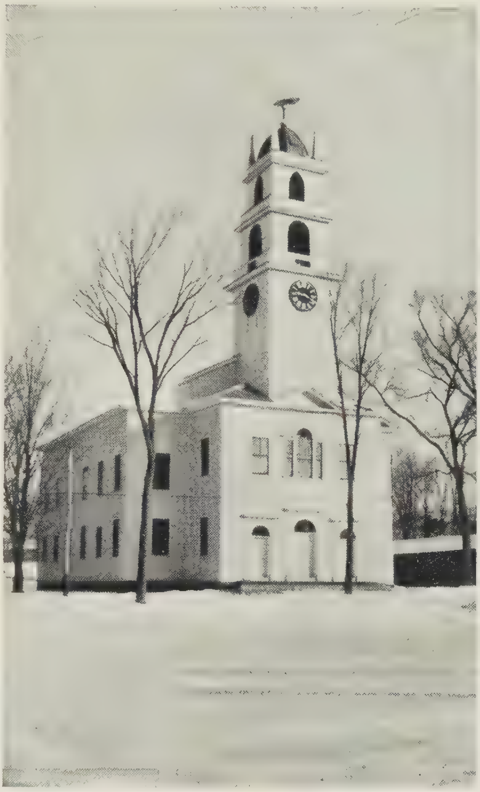

FIG. 21—The old church at Lyme plain.

Mill wheels have turned at fifteen or twenty points on brooks in the township. There is no power site here on the Connecticut River. Lumber, shingles, bobbins, flour, corn meal, and cider seem to have been the chief products, and although one or two of these mills survive to the present day their influence has never gone much beyond the town line. No industry of special interest has ever sprung up in Lyme to distinguish it from its neighbors. Orford, for example, was a producer of soapstone from 1800 to 1835, which was widely used through this country for gravestones, box stoves, mantelpieces, and chimney connections. As late as 1870 we find the "manufactories" in Lyme numbered as 23, with a total number of but 53 "hands employed." Five of these were lumber mills, which employed a total of 20 hands; one was a gristmill with a single "hand"; one a tannery with two "hands"; and one a small starch factory. There was never a cotton or woolen mill in town. From scattered information one is led to think that the "manufactories" of Lyme in the seventies (when Manchester was forging ahead in this field) were cider mills, blacksmith and harnessmakers' shops, a stonecutter's establishment, a tin shop or two, and a milliner's shop.

In the mercantile business and trades these New Hampshire villages show odd division and combination of technique, especially from 1860 to 1890, when specialization was rife yet decline in population put into the hands of a few of the more ambitious and prosperous survivors the diminishing business or trades of many individuals.

Chiefly on account of the absence of factories in Lyme and adjoining towns, there has been hardly any incoming of French Canadians or others of foreign birth. The old New England stock survives, almost unaccompanied. This makes the picture of the decline simpler and clearer than in most New Hampshire towns. In the southern part of the state, especially, foreign-born workers in mills after several years of careful saving of their earnings have purchased deserted farms and are occupying and developing them successfully.

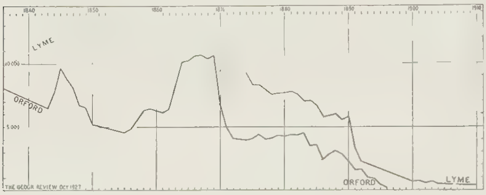

FIG. 22—Graph showing the number of sheep in Lyme and Orford townships from 1836 to 1910.

It is unfortunate that we cannot get exact information as to the extent of land actually under cultivation in the period of greatest occupation (1820–1840) and of the changes in choice of crops and uses of farm land in that early period. From Belknap and others we learn that Indian corn and wheat were regarded, at first, as the leading crops of the state, corn averaging over 40 bushels to the acre and wheat 20 to 50 bushels according to the character of the soil. The intervale lands of the Connecticut valley, such as those along the western side of Lyme, produced the richest crops. Winter rye was thought to be the best crop for newly cleared land. Barley, flax, oats, and peas were raised on land that had been several years under cultivation. Potatoes, averaging 200 to 300 bushels to the acre, were grown everywhere; and in several towns there were large starch mills. Pork, beef, mutton, butter, cheese, and poultry were produced in quantity.

The westward emigration of farmers was reflected in a westward movement of wheatfield and cornfield areas, and by 1845 or 1850 the stony hillsides of Grafton County had largely become sheep pastures. The passing of the era of homespun clothing and the coming in of improved machinery, with growth of mills in southern New England, in the 1830's, created a demand for wool which found ready response here. The number of sheep in the town of Lyme in 1836 was 9867[12] and had increased to 12,557 in 1848 and 13,176 in 1855.[13] Lyme, Hanover, Lebanon, and Walpole were the largest sheep-raising towns in New Hampshire for several decades, but neighboring townships on both sides of the Connecticut River were close competitors, and the Vermont towns as a rule were slightly in the lead. Although the fortunes of the sheep farmer rose and fell irregularly during and after the Civil War, sheep raising continued to be the chief occupation in Lyme until 1890, with the total number, up to 1886, never falling much below 6000 (see Fig. 22). Pride was felt in raising pure Merino stock. Out of 74 "live stock breeders and dealers" in the "Classified Business Directory" in Child's Gazetteer[14] in 1886, 68 farms advertise sheep and only six stock farms specify cattle or swine in addition to sheep.

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[12] C. Benton and S. F. Barry: A Statistical View of the Number of Sheep in the Several Towns and Counties in Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, Pennsylvania, and Ohio . . . in 1836 . . . Cambridge, Mass., 1837.

[13] E. A. Charlton: New Hampshire As It Is, Claremont, N. H., 1855, p. 277.

One credits the traditions and statistics of this vanished sheep industry when he explores the wilderness around Holt's Ledge and Smart's Mountain and finds not only in shrub-covered pasture but even in full-grown pine forest the high stone walls and enclosures and the rudely outlined foundations of sheep barns and sheds. Today there are hardly 150 sheep in the whole township, or scarcely more than one per cent of the old number. In spite of the fact that a recent Bulletin of the U. S. Department of Agriculture[15] has called attention to the practicability of reviving the sheep industry in the New England upland, no one in Lyme seems able or willing to try it. The killing of sheep by dogs, trouble from diseases, and the cost of renewing pasture fences—by sheep wire in place of field stone and rails—are the reasons usually given.

THE FOUR MAPS OF LYME: 1830, 1860, 1892, 1925

The earliest known map of Lyme township showing houses is that of Woodford in 1855.[16] This forms the basis for the plotting of houses on the first map of our series (Pl. IV); but there have been added to it about twenty house sites of earlier date revealed by field work in 1925. For want of better information it is assumed that all houses standing in 1855 were also standing as early as 1830 (when the population was at its maximum) and also that all cellar holes of date prior to 1855 mark sites of houses standing in 1830. While neither assumption can be strictly true, we have in them the only practical means of mapping the approximate condition of things in 1830. Further search over the forested tracts in the eastern part of the township will doubtless disclose a number of other cellar holes of this early period; for even the oldest of them are not badly blurred by time but are merely hidden by bushes and trees.

Although the rugged eastern half of the township even in 1830 was less fully occupied than the western half, nevertheless, roads ran out across it in all directions and climbed far up the slopes of Smart's Mountain and the hills west and south of it. The "Quinttown road" ran diagonally up the southwest spur of Smart's Mountain to the 1700-foot contour and thence northward two miles more beyond "Hardscrabble," passing through a rocky saddle among the hills and down into the township of Orford where, in a remote corner, was the then flourishing village of Quinttown. Here were about fifteen houses, a few sawmills, shops, a schoolhouse or two, and a store; and there was a schoolhouse (gone before 1855) at the top of the long hill on the mountain side, with 50 or 60 pupils. From 1820 or 1830 down to 1878 limestone was quarried on the mountain side and burned for plaster in a small limekiln on the farm half a mile north of this schoolhouse—a rare industry in New Hampshire.

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[14] *Op. cit.*, pp. 341–342.

[15] D. A. Spencer and others: The Sheep Industry, *Yearbook U. S. Dept. of Agric. for 1923*, pp. 229–310.

[16] Map of the town of Lyme, Grafton County; from actual survey by W. C. Eaton. Published by E. M. Woodford . . . Philadelphia, 1855. Scale, 100 rods to an inch.

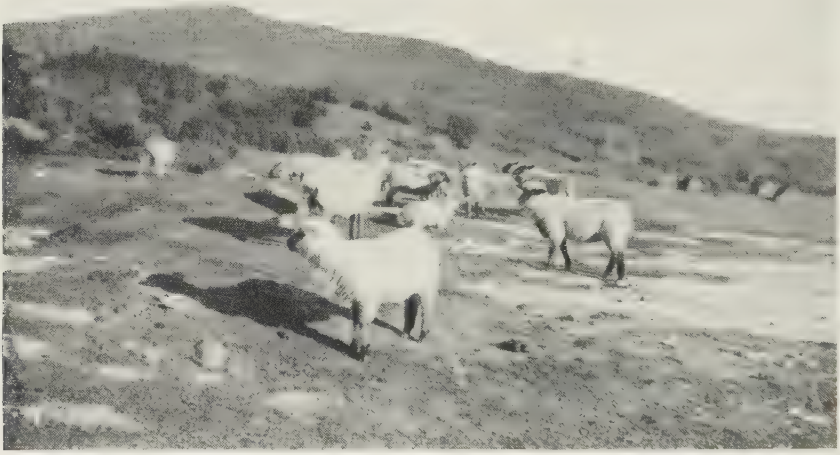

FIG. 23—A handful of sheep where thousands used to graze.

From the old Dorchester road several branch roads, bordered as a rule by stone walls, ran up to farms on both Smart's Mountain and Gline's Hill, where now the cellars and orchards of the pre-1855 period are found well above the 1500-foot contour and over a mile from the main road. The exact upper limit of this early settlement can only be guessed by means of stone walls, pastures cleared of field stone, and occasional apple trees. A few of the locations shown on the map are approximate.

The southeast corner of the township was traversed by the Grafton Turnpike, chartered in 1804, over which a stage made regular trips from Orford through Lyme Center to Canaan and Andover as late as 1847. There were probably more houses on it in 1830 than we have located. At least one road extended eastward from the turnpike into the wooded wilderness south of Gline's Hill, where there was a small settlement still referred to as Tinkhamtown. Two cellar holes have been located here; and somewhere in the woods beyond them there is a "lost" graveyard. It may be that a road once passed all the way over the ridge east of Tinkhamtown into the township of Dorchester.

The rugged pair of hills west of the turnpike, called Bear Hill and Holt's Ledge where cliffs of granite and schist are enveloped in rocky slopes, had their farms also. A road ran up over the high saddle between them. Its north and south ends are still marked by cellar holes and walls; but the course across the saddle itself cannot be traced.

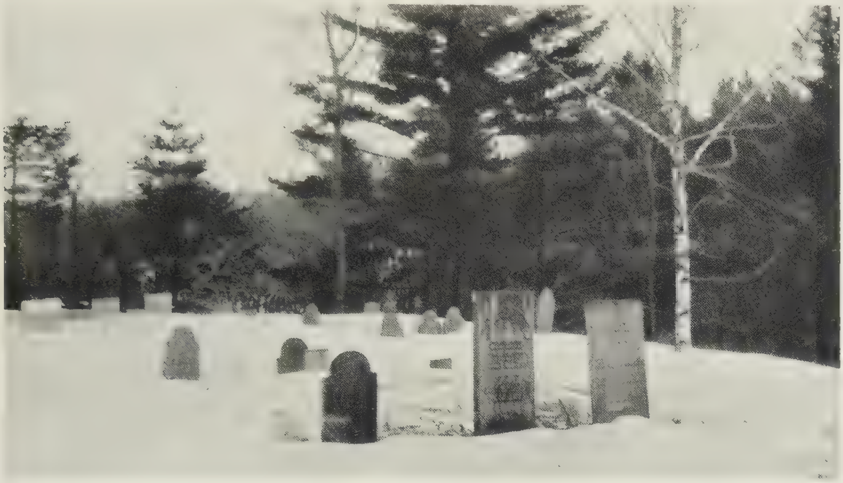

FIG. 24—A corner of the deserted cemetery on the road to Dorchester.

A crooked road with heavy grades swung around the south side of the Bear Hill mass below the 1400-foot contour, on which there were several farms. One of these houses was occupied until 1924, although the road was among the first to fall into disuse.

The western half of the township, though not without uncultivated tracts of highland, was more uniformly occupied. In this region the northeast-southwest system of roads fitted more obediently the grain of rock structure and topography. In the region of Plott Hill, for instance, were four parallel roads about a half mile apart. All were well occupied, although two of them followed valleys, one lay along a sidehill, and the fourth followed the crest line of the bleak ridge of Plott Hill for nearly two miles at an altitude of over 1000 feet. A continuation of this Plott Hill road, a mile or two to the northeast along the western slope of Acorn Hill, was in use in colonial times but was probably abandoned before 1830 and is therefore not shown on the map.

The second map of the series is based upon the one by Walling.[17]

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[17] See footnote 2.

In most respects it agrees in detail with the earlier one by Woodford but is much more accurate as regards directions and distances. It appears that before 1860 at least twenty-eight houses had been abandoned—the number is probably much larger. Twenty-three of these are in the eastern half of the township at an average altitude of more than 1400 feet and all but one above 1100 feet. Of the 321 occupied houses in the town of Lyme in 1860 sixty (or approximately 20 per cent) were in the eastern half of the town. In this section at least six miles of road had been abandoned by 1860.

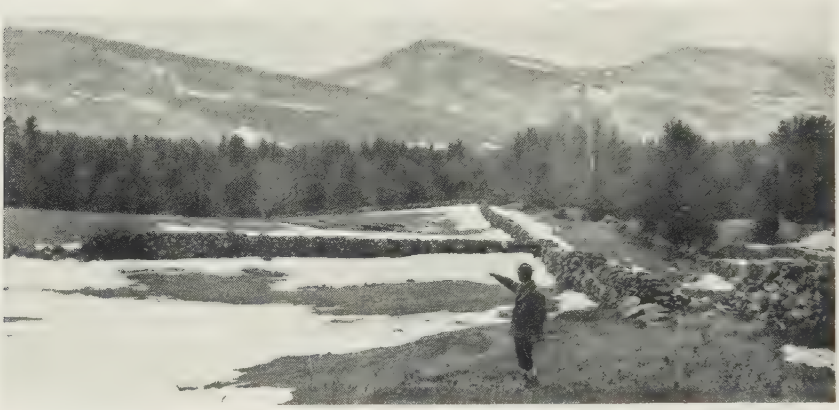

Fig. 25—Down the old Quinttown road toward Holt's Ledge.

The Smart's Mountain-Gline's Hill gap had lost heavily in population, although two or three branch roads still served in 1860 and for five or ten years longer. One new house, indeed, had been added close to the Dorchester line on a low spur of Smart's Mountain; but three houses had been abandoned in that immediate vicinity. A noteworthy record of the outgoing tide from this neighborhood is found in the little graveyard beside the Dorchester road just west of the height of land, where 10 out of 14 of the family names that apear on the 35 headstones are not found among the families living in this district in 1860. They record deaths between 1810 and 1852. In those days of many children, the vanishing of a family name from a community means emigration. Here on the side of Smart's Mountain the tide was ebbing fast by 1860.

The condition of Lyme township in 1892 has been taken from the map in Hurd's Atlas.[18] By that time the Quinttown road had been abandoned, as had also the village at its north end in the next township. The entire northeastern quarter of the township, so largely occupied by Smart's Mountain, thus became a blank on the population map. Up the Dorchester road, east of Lyme Center, all branches of the road system had withered away on the slopes of Smart's Mountain and Gline's Hill; and along the main stem there were left occupied a bare half-dozen houses on a three-mile stretch, with one little schoolhouse and the old graveyard. Location on this old highway had lost its advantage; for by this time the adjoining township of Dorchester had become almost wholly deserted, and no one used this road except these inhabitants of Lyme themselves.

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[18] See footnote 3.

On the turnpike every house had been deserted by 1892, but the road, still kept up, served as a line of communication for a single family who lived on the hill road that ran from the turnpike toward Bear Hill. The rest of this road had been discontinued, two houses on it finding communication southward by steep downhill roads toward Toad Hollow, which was still a real neighborhood. Farther west, Plott Hill had been wholly deserted, although the road along its crest still shows on the 1892 map.

Eight miles of road were given up between 1860 and 1892. Forty-five houses were abandoned. Of these, 19 were in the eastern half of Lyme. In other words, out of 60 occupied houses in this eastern half in 1860, one third were deserted by 1892.

The loss both in houses and in miles of road during the final 30-year period (1892–1925) has been as heavy as during the preceding one. Fifty-nine more houses have become unoccupied. Of these, 22 were in the eastern half of the township; and there are only 24 left. More than 12 miles of road have been given up or at least allowed to become unsafe.

The Dorchester road is still kept in repair and is traveled over from May till November; but it is used in winter only for hauling out pulpwood and cordwood. Five houses on this road that were occupied in 1892 are gone or in ruins. The last occupied house on the road (which was built after 1860) is only halfway out from Lyme Center to the town line. Beyond it on the Dorchester road and its old tributaries are the sites of at least twenty-two former houses. The tide of humanity has drawn down to the 1100-foot contour, leaving the old graveyard in a silent wilderness.

The Quinttown road, long ago become impassable, makes a good trail for the Dartmouth Outing Club. It is nearly five miles from the last occupied house in Lyme to the first one in Orford. The old Grafton Turnpike is in an uncertain state of repair. At the time of our survey, in 1925, parts of it were scarcely passable. From time to time, however, a lumber company gets busy or money is appropriated by town or state to "bush out" the road, fill up the gullies, and mend the culverts; and despite the fact that there is no occupied house on it for several miles through Lyme, Hanover, and Canaan, it may still be saved as a traveled road instead of becoming permanently disused. Its branch, the "Old Tyler Road," is entirely abandoned, the last house on it becoming vacated in 1925. The road over Plott Hill and the crossroad at its north end have been officially closed by the town. But it is in the Acorn Hill neighborhood that the most striking change has come. Here several families have moved away from as many houses during the last few years, and the little schoolhouse is closed. One family only remained in this neighborhood in 1925 on the most remote farm of all, three-quarters of a mile up Trout Brook, one of eight houses still occupied in the township above the 1100-foot contour out of 69 once occupied at that altitude. Not one of the eight houses stands at more than 1150 feet. The 1100-foot contour, therefor, marks a rather definite population strand line for 1925.

So the town is still moving downhill. When will it stop? Where will recovery of strength begin? What social and economic factors will bring it about? And if the tide of population sets in again here, as it has already begun to do in more favored parts of the state, will it rise uniformly across the contours, or will it no longer obey the simple influence of slopes and altitudes?

THE RIO LOA OF NORTHERN CHILE

William E. Rudolph

IN the northern part of Chile, between Arica and the mouth of the Rio Copiapó, there is a stretch of 600 miles of coast line in which only one river reaches the ocean throughout the year. It would be difficult to imagine a place more desolate than this portion of the Atacama Desert—a wind-swept surface, sunburned and sterile, broken here and there by the grimy white of the salars. Through it twines the hidden green canyon of the Loa. Both in itself and in its bearings on man's occupation of the region the Loa is of exceptional interest. On the one hand are the oases of today and the numerous remains of a pre-Spanish civilization; on the other the fact that Chile's longest river in its 252-mile course traverses a country of greatly varied and in many parts unique physiography.

SETTLEMENT IN THE LOA BASIN

The Atacama Desert is indeed one of the most barren surfaces of the earth. Travelers report journeying for days over its pampas without seeing a sign of vegetation. Plant life, however, does exist. Occasionally, in even the most barren waste, one finds a green bush with a small yellow flower; at the most dismal point in an endless white salar appears a tuft of dried grass. A little water hole amid the waste is often marked by a considerable number of species. During a visit to the La Teca spring, on the cattle trail between San Pedro de Atacama and Calama, in the late autumn I found eleven varieties of tola bush and other plants and two varieties of cactus. There are only two types of surface in the entire basin at which I have failed to find some form of vegetation at some period of the year: one at certain salars whose chemical composition makes life impossible—a notable instance is found in parts of the white pampa surrounding the Ojos de San Pedro, where the surface salts contain 45 parts per million of free sulphuric acid—, the other far above the normal snow line.

Many of the plants have a special interest to natives and explorers as denoting the presence of ground water, its depth, volume, and salinity. San Roman[1] mentions a number of these including the tolas; *cuernecilla*, or goat's-horn; jume (*Lycium*); *brea;* and *cachiyuyos* (*Atriplex*), which derives its name from the Quechua "cache," salt, because of the brackish water it indicates. The grass *Chépica* (*Pas-*

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[1] F. J. San Roman: Desiertos i Cordilleras de Atacama (3 vols., Santiago, 1896), Vol. 3, p. 217.

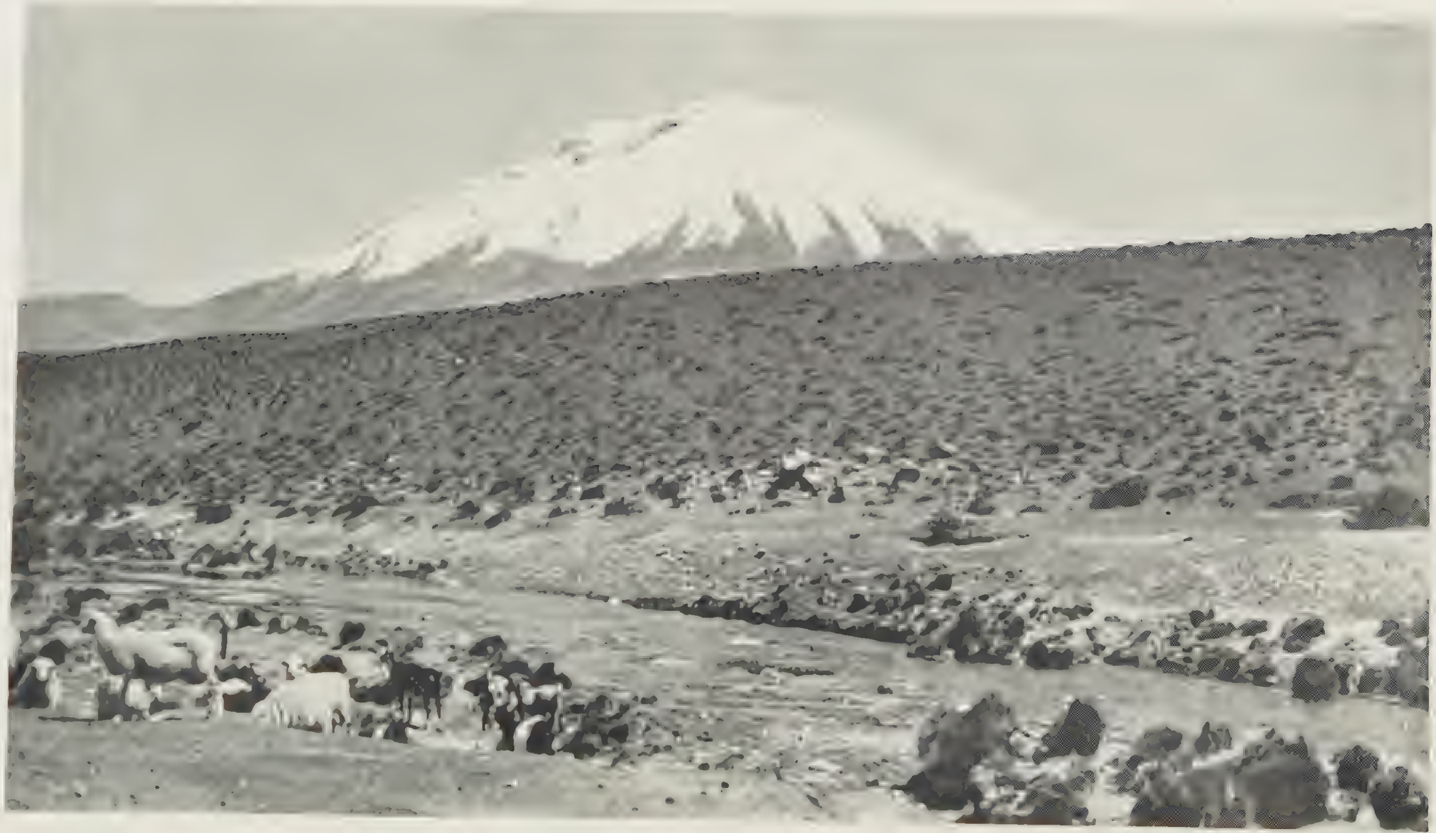

FIG. 1—In the upper basin of the Loa. The volcano San Pablo (5890 m.) and the Rio San Pedro.

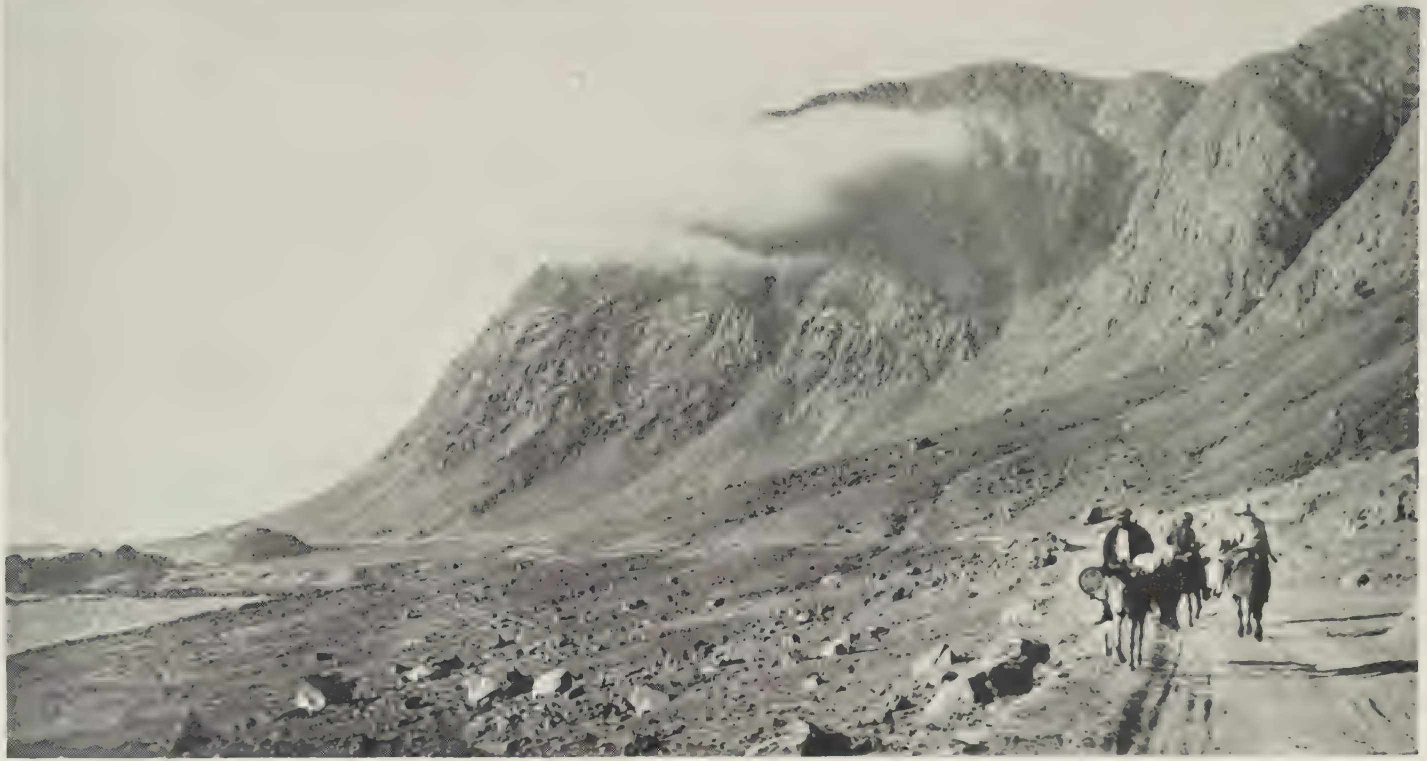

FIG. 2—On the coast near the mouth of the Loa. Note the characteristic afternoon cloud or *camanchaca*, on the slopes of the Coast Range.

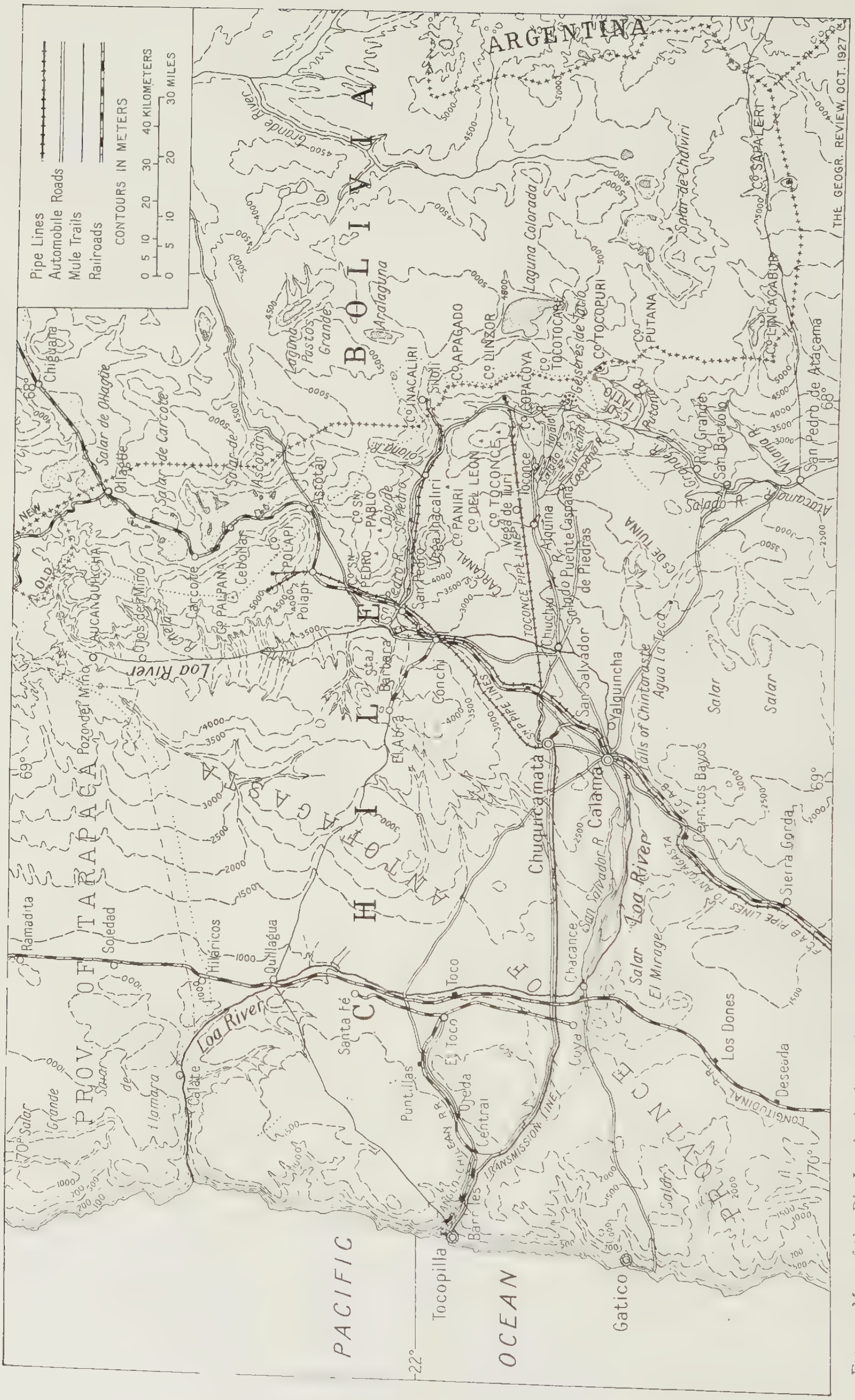

Fig. 3—Map of the Rio Loa basin drawn from the American Geographical Society's Millionth Map of Hispanic America, Iquique sheet, and reduced to approximately 1:2,000,000. The watershed of the basin is indicated by a line of fine dots.

palum vaginatum) of the coast indicates potable water while the *Chépica brava* (*Distichlis thalassica*) of the Cordillera indicates water salty but fit for animals. But plant life is no more than a rarity save in the regions where summer showers occur.

Naturally such a country is repellent to human settlement, but it has an offset in its mineral wealth. The 10,000 square miles of the drainage basin contain a very considerable proportion of the revenue-producing wealth of Chile, including the world's largest proved body of copper ore (at Chuquicamata) and numerous nitrate deposits. The industries to which these give rise account for the greater number of the inhabitants of the basin.

The population of the nitrate oficinas is directly dependent upon the industry itself. European synthetic fertilizers have competed so successfully with the Chilean nitrate that most of the plants treating lower grade *caliche* have lately ceased operation, and the greater part of the population has been returned to the southern and central zones of the country. Previously there were 40,000 people in the sixteen oficinas in the Loa basin; now there are scarcely one-eighth that number.[2]

While the nitrate industry is only sixty years old, mining dates back to ancient times. Today copper minerals are by far the most important ores mined in the region. The mining has been for the most part carried on upon a small scale and has been subject to the state of the market. With downward trend of the price of copper since the World War and the concomitant increase of wages, many of the smaller mines have not been producing for some years. The plant at Chuquicamata is the largest single industrial enterprise in Chile, employing 8000 workmen, who, with their families, constitute a population of 18,000 souls. About nine-tenths are Chileans, and the rest are mainly North Americans.

Practically all the permanent population of the Loa basin is grouped in six agricultural communities watered by the Loa and its tributaries: Calama, with about 1200 inhabitants; Chiuchiu and environs, 500; Quillagua, 300; Caspana, 60; Aiquina and the Vega of Turi, 160; and Toconce, 70. Calama is an old Bolivian town which, although it has become an important division point of the railroad, remains essentially Bolivian as to manners and customs. The houses are mostly of adobe, with corrugated iron roofs. The greater part of the population are Cholos, Indians with some Spanish blood. As with most primitive peoples, the women tend the farms and pastures. Most of the trading is in the hands of Jugoslavs, Spaniards, and Syrians.

There are no sewers, and sanitary facilities are entirely lacking in most cases. Water, however, has been piped by the railroad company to a number of hydrants about the village. Calama also has a good electric light service, based upon water power from the Rio Loa. The farm products of Calama are principally alfalfa and corn. Sheep and llamas are raised on the *vega* (meadows), providing meat and wool. Cattle from Argentina are pastured here before being shipped to the nitrate centers. In recent years there have been established a black powder and a dynamite plant, which are shipping explosives to the mines of Bolivia as well as to the nitrate fields of Chile.

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[2] At this writing, late April, 1927, a number of these oficinas were preparing to resume operation.

Chiuchiu is an old Indian settlement, now four-fifths in ruins. There are indications that the area within which it is situated, extending from the Loa-Salado confluence to the end of the wide canyon floor twelve miles to the north, was a populous center of an older civilization before the Conquest. It was destroyed by the Spaniards during the sixteenth century. The old pueblo in the canyon has remained in ruins since.[3] Chiuchiu of the present day is situated on the *vega*. The town was partly reduced to ruins by an earthquake on May 9, 1877, and completely so by another on January 23, 1878.[4] The alfalfa crops of Chiuchiu are more than double those of Calama per acre irrigated.

Cultivation at Quillagua dates back for centuries. An ambitious scheme for better irrigation came to naught when the earthquake of 1878 partially destroyed the canals. That farming can be conducted there is surprising, considering the high salt content of the water. Lower altitude and a moderate climate are in its favor, there being no green area in the entire basin subjected less to extremes of cold.

Caspana, Aiquina, and Toconce have already been written of as the out-of-the-world villages of the Loa.[5] The cultivated plots at these little towns are arranged in a series of terraces, all available surface being used, including narrow berms at the sides of vertical cliffs. Only at Toconce is water plentiful. Caspana removes the entire flow of its river during the irrigating season. Aiquina depends upon springs, for the waters of the Salado are brackish. Dwellings of adobe with straw roofs and cactus-wood doors, churches with copper bells, and the inevitable cross upon the cliff or hill overlooking the pueblo are characteristic of all three of the villages.

No great cultural changes have occurred among the people inhabiting the Loa basin since the advent of the Spanish conquerors, their customs having survived far better than their numbers. They present an interesting problem for archeologist and anthropologist. Relics of these people are still to be found in the older cemeteries, but

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[3] See an anonymous article, "El mineral de Chuquicamata," *Ingeniería Internacl.*, Vol. 7, 1922, pp. 295–300. New York.

[4] San Roman, *op. cit.*, Vol. 3, p. 391.

[5] Earl Hanson: Out-of-the-World Villages of Atacama, *Geogr. Rev.*, Vol. 16, 1926, pp. 365–377.

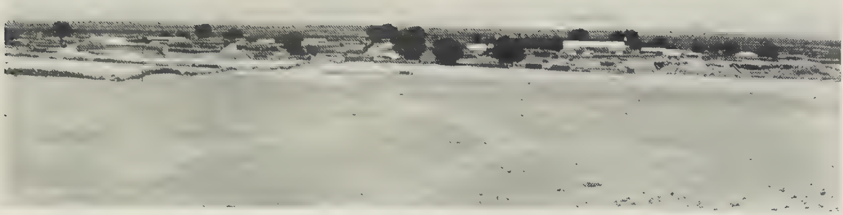

FIG. 4

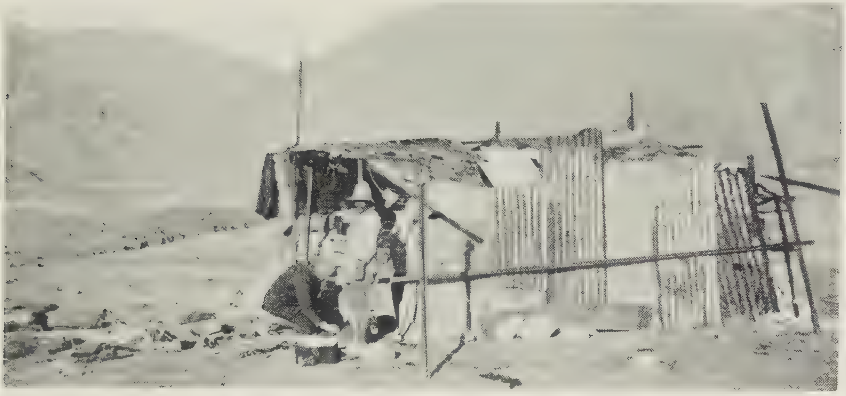

FIG. 5

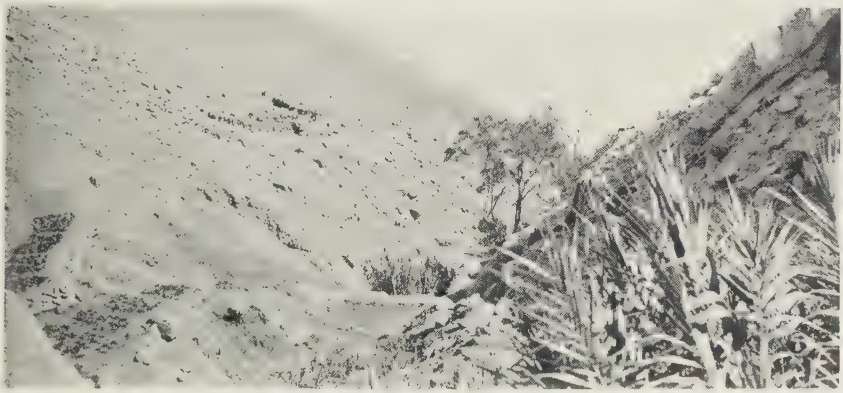

FIG. 6

FIG. 4—Chiuchiu, a green spot in the desert. See also Figures 7 and 21.

FIG. 5—Shelter of present-day Changos near mouth of the Loa.

FIG. 6—Terraces and stone walls dating back to the earlier Changos at the water hole of Mamilla, about eight miles north of Tocopilla.

not for long. Mining enterprises have brought a host of curio seekers from other countries, and incentive has thus been lent to the more daring natives to dig up the buried trinkets. At this writing but little remains undisturbed of the burial grounds of Chiuchiu. Skulls have been scattered promiscuously over the ground or arranged as subjects for the amateur photographer.

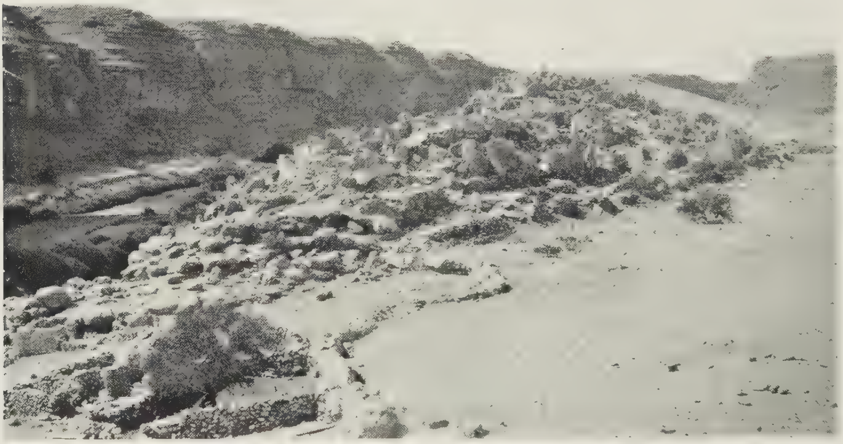

FIG. 7—The fortress in the canyon above Chiuchiu. A portion of the old irrigation canal appears in the foreground at the left of the trail.

THE CHANGOS OF THE COAST

The earliest inhabitants of the Loa valleys were probably the Atacamas, or Atacameños, a race which came from the east. Prior to their arrival perhaps only the coast had been peopled by fishing tribes, the Changos, whose development seems to have been more or less upon a level with the Old World peoples of the Paleolithic age. These people must have existed upon fish as a main diet, although there are evidences that they also cultivated the land upon a small scale. Where the Loa emerges from its canyon about a mile from the sea, there are remains of terraces and algarrobo trees at the north side of the stream. One finds no evidences of an irrigation canal, and so it would appear as if the Changos carried river water to the farms, possibly in sealskins. Similar terraces are found at the Quebrada of Mamilla, about eight miles north of Tocopilla, where springs of potable water emerge from the cliffs far above the sea. Most of the remains of the Changos, however, are beside the beach at the northern sides of promontories. They are marked by large piles of shells, and excavations at such places have disclosed bones in sitting positions, together with cooking utensils, arms, and fishing implements. One observer has commented on the thickening of the cervical vertebrae, which he ascribes to the constant stooped position which the Changos were accustomed to maintain. He has also found bones of dogs beside the bodies, leading to the belief that the Changos had domesticated this animal. They had no metals but used flint and quartz.[6] Fuel was quite plentiful, for parts of the Coast Range are covered with cactus owing to the moisture of the *camanchaca*, or afternoon cloud (Fig. 2). The stone hooks and arrowheads found in and about the graves were perhaps used in conjunction with spears of this cactus, or of the cane which grows at Mamilla.

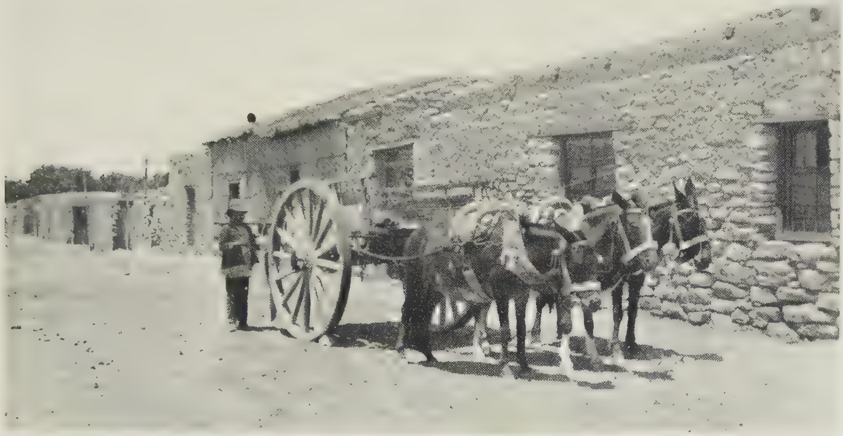

FIG. 8—Chiuchiu's principal vehicle of haulage.

The Changos are said to have disappeared as a race about the middle of the last century, although people who possess much of their fishing instinct if but little of their blood have replaced them in small isolated groups along the coast of the province of Antofagasta. The town folk speak of them as Changos or Chungungos, both having become terms of derision. It is said that they work tiny veins of gold in the Coast Range when the fishing is not good. The regions inhabited by them are often difficult to reach by land because of the sheer precipices and treacherous talus of the coastal escarpment and difficult to reach by sea because of the heavy surf which pounds against the abrupt coast. Of some 30 miles of coast south of the city of Antofagasta, San Roman wrote in 1896[7] that the region was inaccessible because of its steep declivities, there being no record of the return of any traveler who had ventured there. Yet these inaccessible places may be clearly seen from the decks of the west-

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[6] Perhaps the Changos of the last century had learned about smelting metals from the ores so abundant in the Coast Range. There are remains of furnaces as well as masses of slag in the regions frequented by them. In the older graves, however, no metals appear to have been found.

[7] San Roman: *op. cit.*, Vol. 2, p. 392.

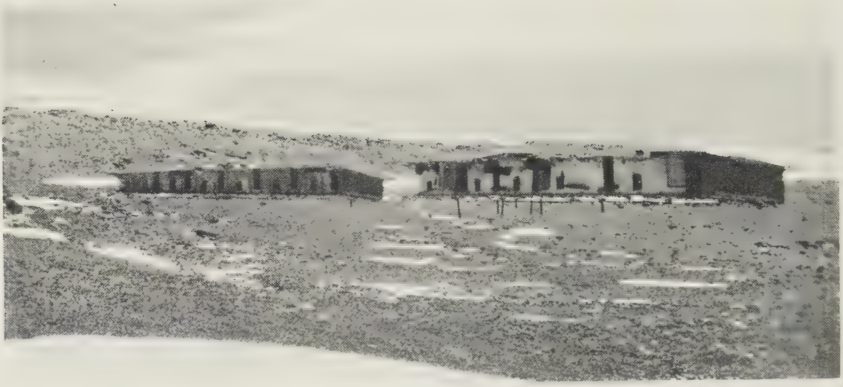

FIG. 9

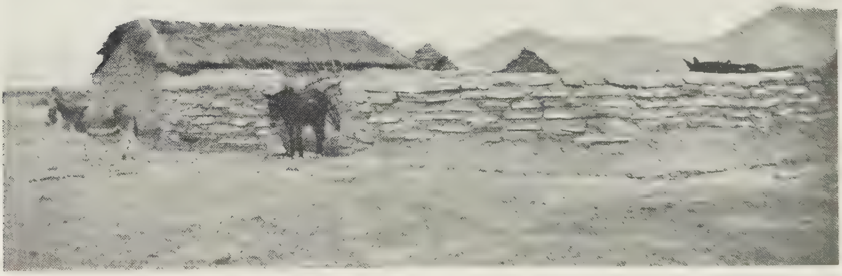

FIG. 10

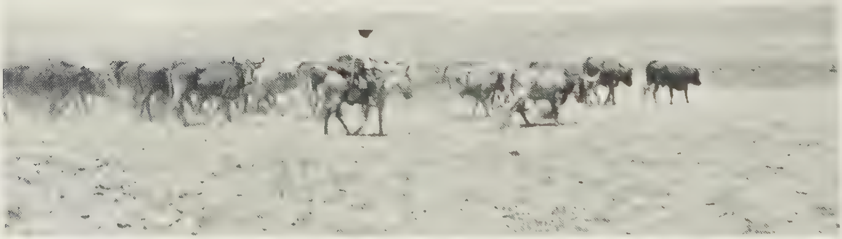

FIG. 11

FIG. 9—A sulphur mine camp above the snow line in the Loa Basin.
FIG. 10—At the Vega of Turi.
FIG. 11—On the cattle trail from the Argentine to Calama.

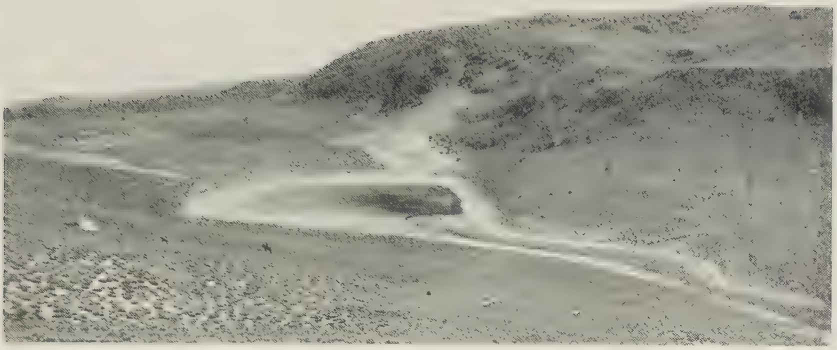

FIG. 12

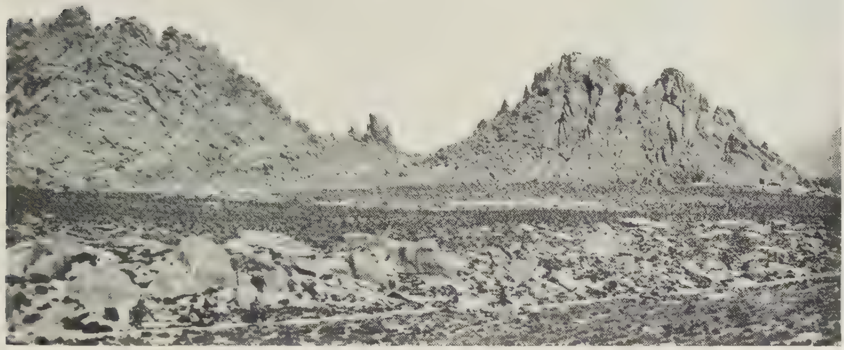

FIG. 13

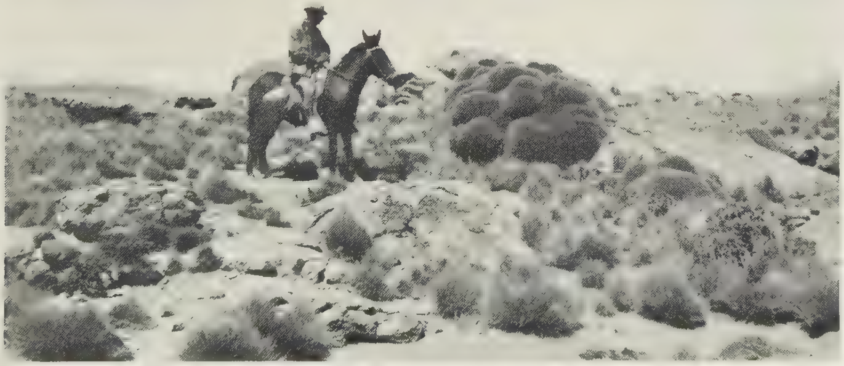

FIG. 14

FIG. 12—A laguna of the high cordillera. Extrusions of trachyte have caused it to have both underground inlet and outlet.

FIG. 13—At the headwaters of the Hojalar, a headwater stream of the Salado.

FIG. 14—Llareta, a mosslike plant, the chief fuel of the region.

coast steamers. Some months ago the Antofagasta press carried accounts of an airplane which had been wrecked within this region. After several unsuccessful attempts to reach it both by land and sea, two Changos volunteered their services with successful outcome.

The writer found four of these present-day Changos, three men and a woman, living at the mouth of the Loa, in April, 1927. They had built a crude shelter of burlap bags and oil cans on the south side of the river at a short distance from the surf and had installed an apparatus for distilling river water, using metal receptacles and piping removed from an abandoned gold mine. There was an irrigation ditch, with terraces for cultivation on the flat above the beach. Both were dry, however, their owners stating that the floods of 1925 had destroyed the division channel. These people had no boat. They reckoned distances in terms of days of walking, a day's journey being about twenty miles. They were accustomed to making trips to Quillagua to exchange fish and clams for tea and corn.

The Loa in Relation to Public Utilities

The waters of the Loa have had an important influence upon trade routes by supporting such supply stations as Calama and Chiuchiu. Yet neither the footpaths of Inca times, the mule trails of the later centuries, nor the railroads of today correspond with the course of the river. The oldest trail in the Atacama Desert is probably the Inca road that stretched from Cuzco through San Pedro de Atacama to the Rio Copiapó. This still remains the main artery of travel for the highland dwellers. It crosses all the eastern feeders of the Loa at right angles just west of the present Chile-Bolivia frontier, but it never approaches the Loa itself by some twenty-five miles. Other routes have been established since the Conquest, from Argentina and from the older mines to ports of the Pacific. These converge on one or the other of the settlements along the river, there to cross the stream but rarely to follow in its course. The Rio Loa meant a deep canyon to be shunned because of the difficult and often dangerous crossing which it involved.

Later came the railroads, one connecting the Bolivian altiplano with Antofagasta, a second furnishing outlet for nitrate to the port of Tocopilla, and a third stretching due north and south to form a link of the Longitudinal Railroad of Chile. Only the last follows the Loa, from Chacance to Quillagua. In the course of railroad building the Loa has been bridged at Conchi by a structure still considered the highest railroad span in the world, but now it is unsafe and no longer in use.

Pipe lines convey Loa waters to towns and industrial plants, their flow depending upon gravity in the upper and on pumping stations

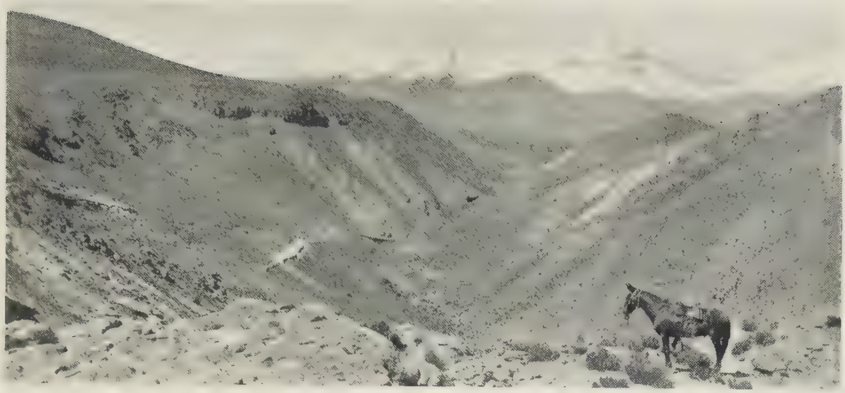

FIG. 15

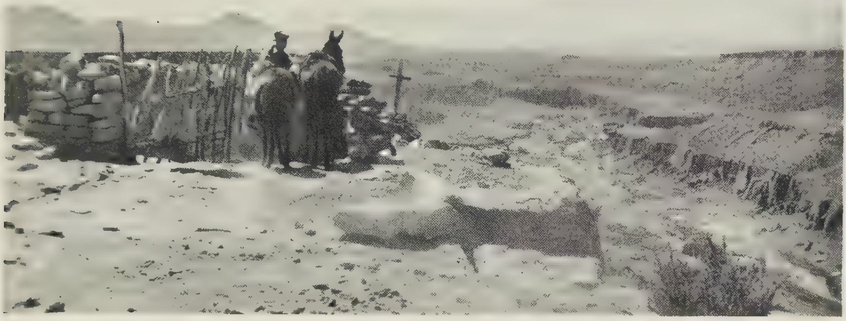

FIG. 16

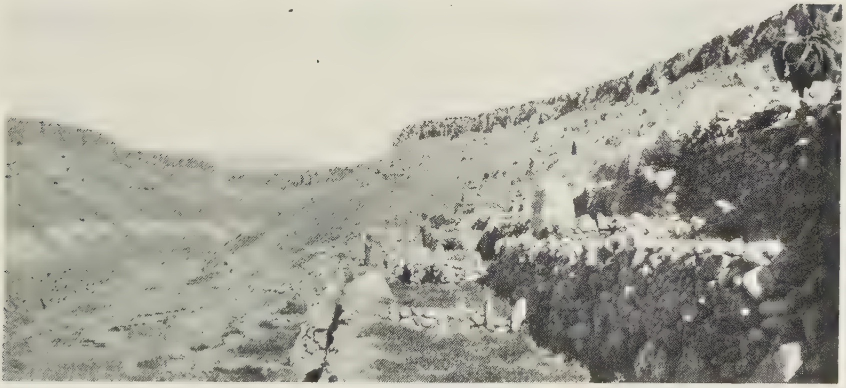

FIG. 17

FIG. 15—Canyon of the Rio Toconce, looking toward the frontier range. Mule trail and pipe line at the left.

FIG. 16—Gate at the trail into the canyon at Caspana.

FIG. 17—Terraces on the slopes of the canyon of Rio Caspana.

in the lower sections. Steel or cast-iron pipe has been used in practically all cases. Wood-stave lines, although cheaper, are hardly practical in a region where water is so scarce and lawless citizens all too plentiful. The lines stretch across the desert for long distances, that from Toconce being 54 miles between the reservoir and the first discharge tank. The lines are laid upon the ground, as far as possible, and covered, except at joints, to protect them against the effects of the wide daily temperature ranges. They are supervised from stations about twenty miles apart by line riders, whose duties are to operate air release valves, make repairs, and patrol the line. In the event of a break, the line rider may have to depend upon mules for haulage through rugged country, but he must get the main repaired with all possible despatch, for thousands of people depend upon its supply.

Generally no charge is made for water at the industrial plants, but in Antofagasta and other towns supplied by pipe line a price of $1.40 (Chilean currency) per metric ton has been fixed. This amounts to about six and a half cents (U. S. money) a hundred gallons. The rate is more than double that charged for water in England, but this is not remarkable in view of the distance of transportation.[8] Actually, only about 25 cents a month (U. S. money) per capita is expended for water at these centers, the quantity used being restricted to from 20 per cent to 50 per cent of normal consumption of other countries, both by law and by the poverty of the people.

At the pueblos to which potable water must be hauled by rail or cart, however, the charges are much higher. Quillagua receives a car of water (about 3000 gallons) weekly, from Pintados, 75 miles north; and this is sold to the townspeople at the rate of 50 cents Chilean (6 cents U. S. currency) per five-gallon can. Despite this high price for potable water, the people do not drink the river water here because of its high content of injurious salts. At one of the stations on the railroad connecting Toco to Tocopilla, the writer paid an equal rate for water pumped from a Loa evaporating plant, this amounting to 60 cents (U. S. currency) for sufficient to water five mules.

A number of small water power concessions have been developed between Chacance and Quillagua by the nitrate companies. As a source of energy, however, the harnessing of the Loa waters has hardly begun. The initial cost of hydro-electric power installations, at about $500 per kilowatt, is too high to appear attractive in comparison with generating plants using oil. At the upper feeders of the Loa water is scarce, whereas fall is plentiful: a series of power houses using the same water again and again is therefore necessary for projects there. The Salado and its tributaries may be utilized through a head of five thousand feet in thirty-five miles. Flows from springs even as little as one-tenth of a cubic foot per second, when at the higher elevations, represent important potential energy to the engineer and are well worth diverting into his canals. Storage reservoirs are seldom advantageous, because of excessive evaporation and constancy of stream flow.

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[8] The pipe-line distance, Siloli to Antofagasta, is 230 miles.

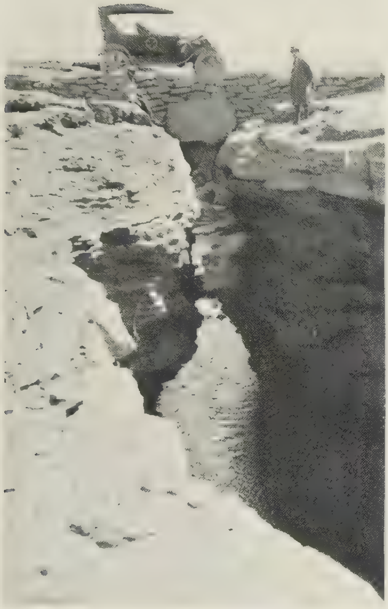

FIG. 18

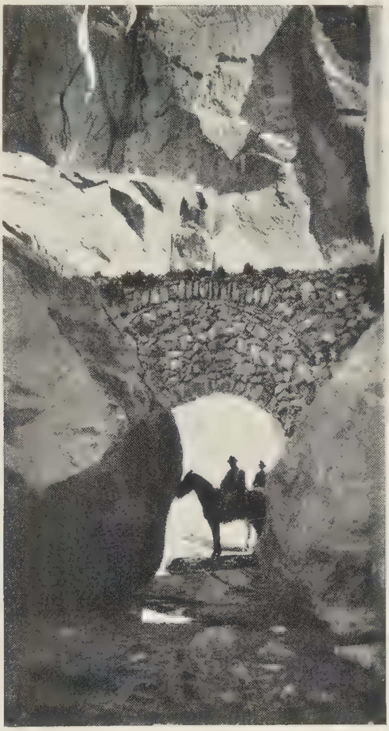

FIG. 19

FIG. 18—Puente de Piedras on the trail from Chiuchiu to Aiquina.

FIG. 19—Arch built by Indians to support irrigation canal—less than one foot wide—near pueblo of Toconce.

GOVERNMENT REGULATION OF WATER

During 1920 the Chilean Government passed laws to regulate the use of Loa waters in the interests of present and future industries. These laws state five uses for which concessions covering such waters may be granted, with preference in the order named: 1, drinking supplies for cities, oficinas, and industrial plants, and requirements for locomotives and steam boilers; 2, refining nitrate; 3, industries, including mining; 4, irrigation; 5, hydro-electric developments.

The amounts of water to be allowed individual enterprises under each of the five heads are clearly defined. Naturally, concessions of the potable waters are restricted to the first purpose.

At the present time hardly half of the surplus waters of the Loa is being used for farming. In a region where food is scarce and expensive, with industries providing an ever increasing population, this is indeed strange. But to install modern irrigation works requires money; and northern Chile is far from the seat of government, which makes such appropriations. Perhaps the recent collapse of the nitrate industry will serve to accentuate the need. Meanwhile, the Loa continues to pour treasure into the sea.

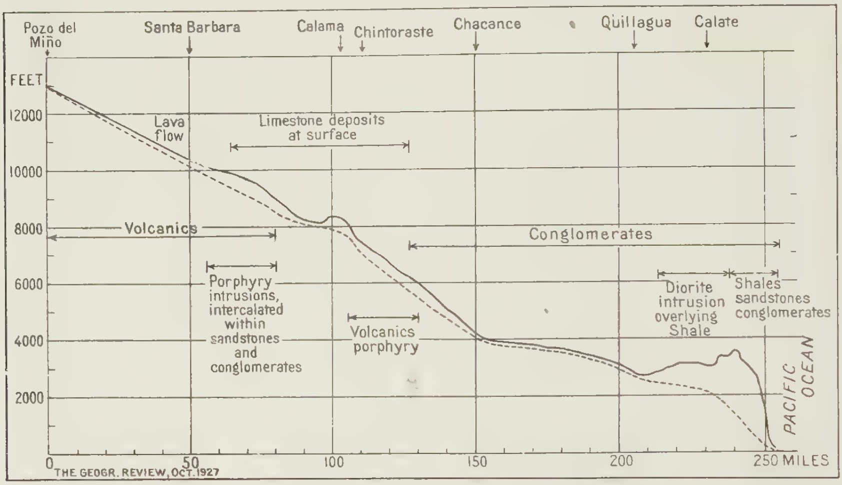

FIG. 20—Profile of the Rio Loa canyon with indications of the geology of the region. Dashed line represents the flow line, the solid line the top of the canyon walls. Vertical scale about fifty times horizontal scale.

PHYSIOGRAPHY OF THE LOA WATERSHED

The physiographic history of the Loa system goes back to Tertiary time, drainage being initiated on the then existent western slope of the Andes when they were not yet so high as to impede the passage of moisture-laden winds. Diminution of precipitation toward the close of the Tertiary, together with the advanced stage of erosion tended to level the valley floors by stream aggradation. Volcanic eruptions during the late Tertiary completed the filling of the valleys and *quebradas*, even covering the hills which marked the relief of that surface of erosion.[9] There followed subsidence with concurrent rifting and block faulting that developed both graben and broad depressed areas.[10] The portion of the Central Valley of Chile through which the Loa pursues its northward course between Chacance and Quillagua is one of these depressions. The majority of the basins are without outlet, although some slope toward *quebradas* which reach the Pacific, as at Antofagasta. Subsequent uplift[11] brought the entire mountain region to its present continuously lofty level, and with it came the arid climate. Cretaceous formations, which appear at altitudes of 13,000 to 14,000 feet bordering upon the Loa basin, show to what heights these lands have been lifted. The last page of Andean history followed, one of pronounced volcanic activity which was probably staged throughout the Pleistocene, building the mountains still higher. That the period of volcanism did not terminate before the end of the Pleistocene, or perhaps even at the beginning of the present era, is evidenced by the manner in which lava flows have obliterated glacial features throughout the region.

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[9] Johannes Felsch: Las corrientes de agua subterranea en las zonas Central y Norte de Chile, La Riqueza Minera de Chile, June, 1926, Santiago.

[10] Robert Hawxhurst, Jr.: The Andean Salares, *Engineering and Mining Journ.*, Vol. 122, 1926, pp. 419 and 534.

Over the surfaces thus formed the Loa flows, its sources among the now practically extinct volcanoes and its direction consequent upon the warped slopes. The courses of its feeders have been influenced entirely by the later lava flows, the region being interlaced with dry *quebradas* marking former drainage lines. In general, the present canyons are giants as compared with the older ones, indicating that only since the end of the volcanism have there been quiet intervals of any duration. Some of the dry *quebradas*, as exemplified at Conchi, intersect the main canyon well above floor level, as if their waters had ceased with elevation and the coming of the arid climate, whereas the through drainage channel had continued to cut deeper owing to the steeper descent. Valley widening, on the other hand, has been extremely slow since the rains ceased, with deep spectacular canyons resulting.

The Upper Loa and Its Tributaries

Whereas a large number of *quebradas* intersect the Loa above Santa Barbara, only one, the Rio Chela, carries water at all seasons of the year. The increases in volume at this section are due to seepage, mainly from the left bank.

The Rio San Pedro has its source in springs in Bolivian territory as the Rio Siloli. Its waters enter a deep canyon where, about 1500 feet east of the Chile-Bolivia frontier, is located the main intake of the Antofagasta-Bolivia Railroad at an elevation of 14,163 feet. A pipe line removes over two cubic feet per second at this point, used both for operating the railroad and as supply for the city of Antofagasta and the nitrate pampa.

Several streams join the Siloli after it crosses into Chile, drainages typical of the mountain region, flowing during the afternoon while the sun's rays are upon the snows but ceasing at night. Soon the river disappears entirely within a sand-filled lake originated by a lava flow from Panieri. Where the Rio Siloli (called Inacaliri at this place) enters, there is a marsh, but the lower portion of the area is dry. Ducks and other aquatic birds are found here in larger numbers, and stone arrowheads at the shores indicate that these are ancient haunts.

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[11] Amounting to at least a mile, according to Isaiah Bowman: The Andes of Southern Peru, New York, 1916, p. 200.

Where the Rio San Pedro reappears, at a lagoon fed by springs, the volume has been considerably increased, and the salt content also. Pipe lines leading to Chuquicamata and to Antofagasta draw off some of this flow for industrial purposes. Where the river is again diverted by lava flows to a course south of the older one, both the earlier rhyolite and the later lava flow, the one light and the other dark, show strikingly in the walls of the new canyon. The comparatively recent period of the flow is attested by pebbles of pumice which float down the river, causing no end of trouble to the caretakers of the reservoirs.

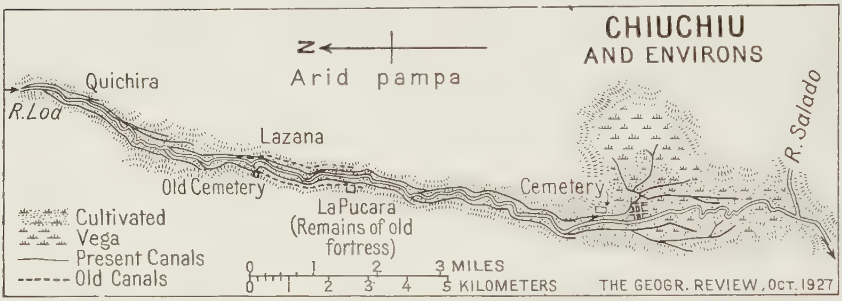

FIG. 21—The Loa valley in the neighborhood of Chiuchiu. Compare Figures 4 and 7.

Below its confluence with the San Pedro at the small green area of Santa Barbara, the Loa is enclosed within deep narrow confines. At Quichira the *quebrada* widens and the cultivated zone of Chiuchiu begins. Thirteen canals (Fig. 21) remove water just below Quichira, having a total flow of about 80 cubic feet per second. During the irrigating season, from September to March, about 56 cubic feet per second return to the river as surface drainage and filtration. In winter the losses are far less.

The Salado joins the Loa below Chiuchiu, carrying a flow slightly greater than that left in the main stream after irrigating the farm belt. The Hojalar and the upper Salado, two of the four rivulets contributing to the Salado, are saline, increasing the salt content of the Loa to such an extent that the government once considered their diversion to evaporating basins.

The Toconce rises in a number of springs, its waters emerging at a constant temperature of 75° F. A pipe line supplying potable water to Chuquicamata has its intake at the sources, and the canal of the village of Toconce is fed some miles below. The Rio Caspana, a mere brooklet in contrast with the spectacular canyon which it has cut through 300 feet of rhyolite, also serves a farming area.

At the head of the Salado are the geysers of Copacoya, or of the Tatio as the region is commonly known, where steam outlets, mud vents, pools of boiling water, and mounds of geyserite appear on the site of an old crater (Fig. 22). The Indian name Tatio, applied to the hills surrounding them, means burnt, and there are indications that volcanic activities disappeared at a comparatively recent time, perhaps when the first humans began to appear in the region. At some of the boiling springs are regular intermittent explosions, whereas at others the surges are irregular. Large pools, some up to 15 feet in diameter, quietly simmer though they rarely boil. Columns of steam form a striking spectacle, particularly just before sunrise when the wind is low. Small craters, cylindrical rather than conical in shape, stand about six feet above the plain, some extinct and others containing boiling water.

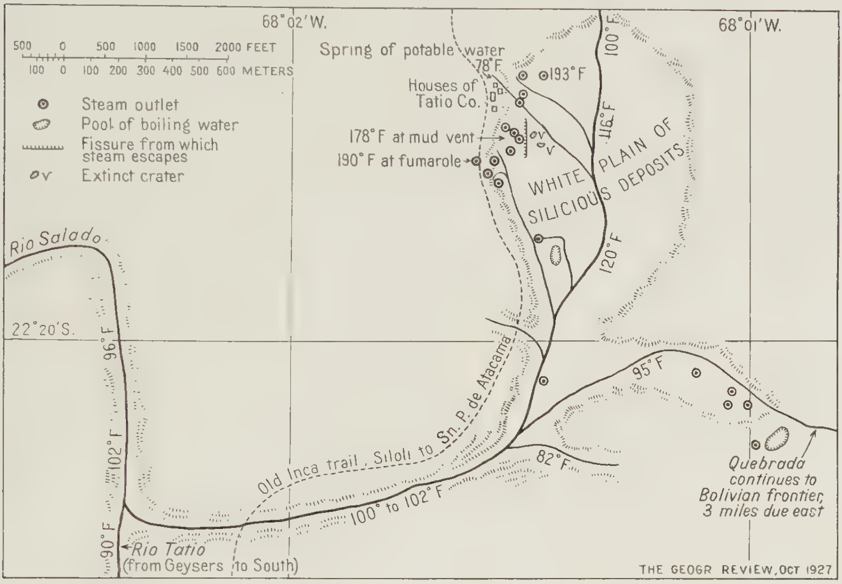
68°02′W.
68°01′W.
500 0 500 1000 1500 2000 FEET
100 0 100 200 300 400 500 600 METERS
Steam outlet
Pool of boiling water
Fissure from which steam escapes
Extinct crater
Spring of potable water
78°F
193°F
Houses of Tatio Co.
178°F at mud vent
190°F at fumarole
100°F
116°F
WHITE SILICIOUS PLAIN OF DEPOSITS
120°F
Rio Salado
22°20′S.
96°F
102°F
90°F
Rio Tatio (from Geysers to South)
Old Inca trail, Siloli to Sn. P. de Atacama
100° to 102°F
82°F
95°F
Quebrada continues to Bolivian frontier, 3 miles due east
THE GEOGR REVIEW, OCT 1927

FIG. 22—The main basin of geysers at Tatio, at the head of the Rio Salado. Compare Figures 23 and 24.

The waters of the Tatio are derived from meteoric waters which, flowing through rock fissures dating back to the Andean uplift, reach depths where the temperatures are still very high. There they are transformed into steam,[12] which finds its outlets through the same crevices in the rock strata. All indications are that the last stages of

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[12] The steam contains about eight per cent of carbon dioxide and hydrogen sulphide, of which the former predominates. Methane and other hydrocarbons do not exist.

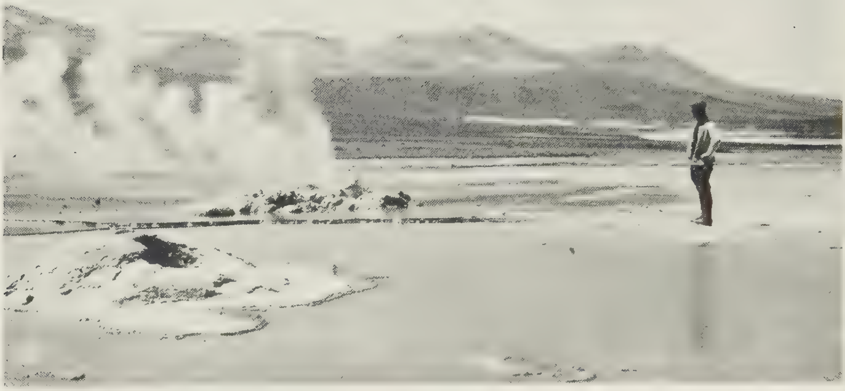

FIG. 23—At the geysers of Tatio. Compare Figure 22.

volcanism have been reached, and in the writer's opinion no juvenile waters are being given forth at this time. Temperatures of the steam range to 193° F., whereas the boiling point is 188° F. at this altitude. All of the hot waters are highly saline, but springs of potable water of much lower temperature emerge from the adjacent hillside.

Some years ago a company was incorporated for the purpose of developing the steam resources of the Tatio, thus to provide cheap power for the nitrate industry. A few houses were erected and experimental drilling begun. Then the work stopped, for, whereas an enormous thermal reserve is available, the large capital expenditure required for power production did not appear justified. Meanwhile, the fumaroles continue to pour out their heat to the cold air of the mountains. Picturesque they are, as is the uninhabited region about them, but isolated and inaccessible.

The *quebrada* of the Salado is eroded out of rhyolite, trachyte, and softer volcanics as far as the eastern limits of these flows, below Aiquina. There the surface changes to a younger limestone deposited in beds 100 to 150 feet thick. A unique canyon has resulted where the Salado cuts through the limestone formation. The river flows at a depth of about 50 feet below a gently sloping plain, with width of gorge at the surface only two to eight feet. Within the canyon there is much more space, as if the topping over a subterranean flow had caved in. A bridge, known as the Puente de Piedras, has been constructed as part of the old Indian trail from Chiuchiu eastward. This structure, with a span between abutments of 2 feet and height above river level of 43 feet, probably has a smaller ratio of width to height than any other bridge in the world. One may jump across the chasm with ease, but woe be to the traveler who stumbles into it at

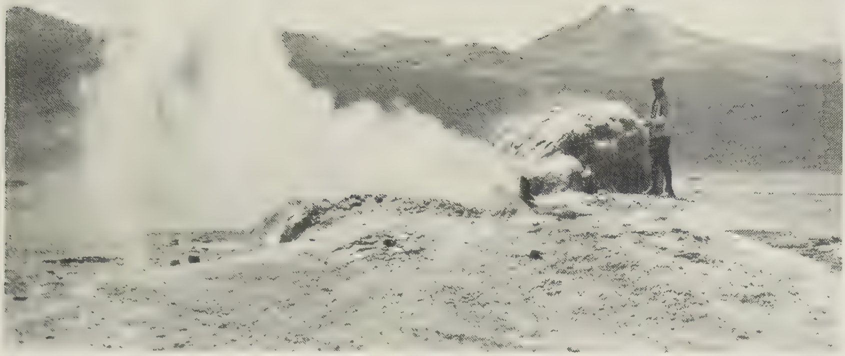

FIG. 24—Present steam outlet beside older vent at the Tatio.

night. The surface of the pampa is unbroken to the very brink of the precipice, and only a high stone monument indicates the place of crossing. The aborigines who built the bridge needed no engineering formulae, and it is probable that their work will remain long after more accurately calculated structures have failed or been replaced.

An ancient river three miles wide, filled up probably from great depths by sediments, meets the Salado at the lower end of its narrow canyon. The stream makes an abrupt bend at this point, following the older watercourse. There are indications that the wide *quebrada*, now dry above its intersection with the Salado, drained the San Pedro valley at an earlier time before volcanic extrusions blocked the way. There must be a considerable underground flow to the Salado through the dry valley, this being the only explanation of the high increase in volume between Aiquina and the confluence with the Loa.

THE LOWER LOA

The limestone deposits encountered in the lower course of the Salado extend westward to include the arable lands of Calama and the lower part of Chiuchiu. Some of these fresh-water limestones are of remarkable purity, those near San Salvador assaying between 60 per cent and 95 per cent calcium carbonate. They have formed where river waters have spread over *vegas*, and the process still continues in the environs of Calama.

At the confluence with the Salado, the Loa's flow reaches its peak. Almost immediately thereafter it begins to lose by seepage through the limestones to an older channel. The waters disappearing in this manner are not lost, however, for the stream which they eventually unite to form, the Rio San Salvador, enters the main valley at Chacance.

At Yalquincha one of the largest farming districts in northern Chile, that of Calama, begins. Sixteen canals for irrigation and three for water power installations, spread the waters over a cultivated area of 4400 acres (Fig. 25). A much reduced stream leaves this district, for not only has water been spent upon alfalfa and corn, but there has been seepage into the Quetena and Opache *quebradas* which feed the San Salvador paralleling the Loa at a distance of a few miles. Less than half of the water which enters Yalquincha drops over the cataract of Chunchurie (Chintoraste) where arid desert again closes in. The main falls at this point are 100 feet in height, a picturesque sight. A more impressive view existed in the past, for much of the flow now occupies a channel to the north avoiding the main falls. There are indications that the arroyo Quetena has been formed since the coming of man and is due to irrigation seepage, but the Opache appears to originate from underground flows from points farther up. This stream of 15 cubic feet per second gushes forth from a rock wall and has eroded a narrow box canyon. It disappears and reappears in its course to the San Salvador.

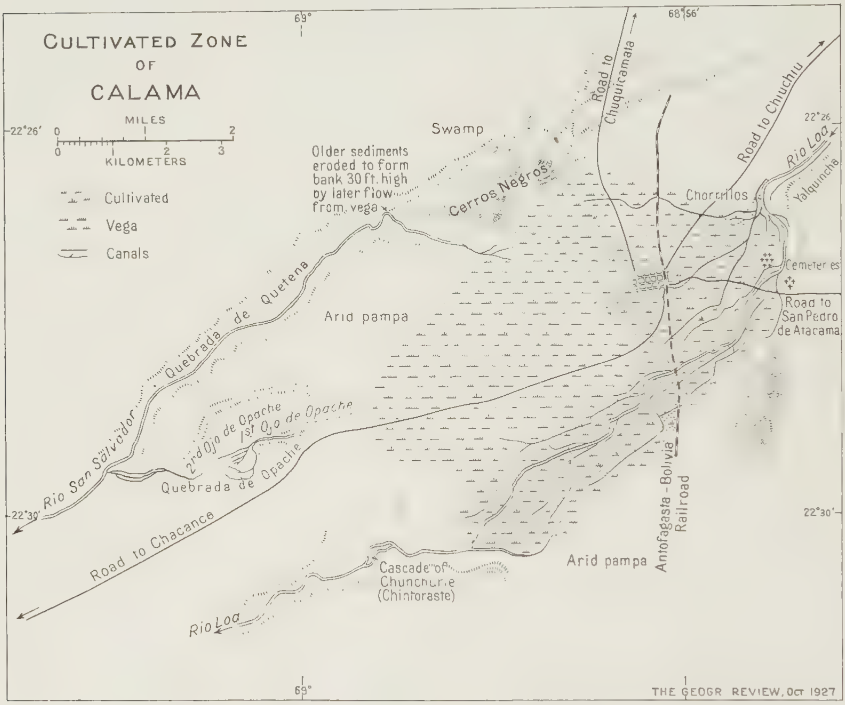

FIG. 25—The cultivated zone of Calama.

Pumping stations and hydro power installations depend upon the Loa below Chacance, and at Quillagua two irrigation canals are fed. At Calate the small but very brackish stream of the Rio Amargas, the overflow of the Salar de Llamara, is received. From that point to its outlet, the Rio Loa lies hidden in a deep canyon, protected from heavy evaporation losses. At the outlet the volume is but little more than half that at the point of maximum flow. San Roman wrote[13] that the waters disappeared in the sands of the beach at that point, and this had been confirmed by other travelers before the year 1925. In April, 1927, however, I found that the river had cut a new channel directly into the ocean. Apparently the floods of 1925 had wrought the change.

TABLE I—RAINFALL OBSERVATIONS AT SAN PEDRO STATION, ANTOFAGASTA-BOLIVIA RAILWAY*

(*In inches*)

YEAR	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	TOTAL
1917	.827	.342	.143	.004	0	0	.04	0	0	0	0	.068	1.424
1918	.596	.493	.66	0	.08	.048	0	0	.083	0	0	0	1.96

* Data from Gustavo Lira: Aguas del Rio Loa, Santiago, 1921. The maximum in 24 hours was 0.294 inches in 1917, 0.31 in 1918. Elevation of station, 3223 meters (10,570 feet).

The statement has frequently been made that the Loa dries up completely during certain seasons of the year. This is not a fact. There are periods of the day when no water flows under the railroad bridge at Quillagua, but this is due to impounding of the entire flow in reservoirs. The river draws its waters from the snows of the Cordillera, a constant supply, and considerable expansion of farming or of industrial enterprises would be required appreciably to increase water losses.

RAINFALL AND EVAPORATION

Over only 2700 square miles of drainage area, hardly more than one quarter of the whole, does precipitation occur except at rare intervals. This area lies above ten thousand feet, and precipitation is usually confined to the months of January, February, and March. Below that elevation there are occasional light showers, perhaps two in a year, with a heavy downpour at ten- or twenty-year intervals. Normal rainfall averages less than 0.04 inches per year.[14] The summer rains contribute perhaps two-thirds of the entire run-off of the Loa feeders. The rest is derived from snows born of condensation on the high flanks of the Cordillera.

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[13] San Roman, *op. cit.*, Vol. 3, p. 116.

[14] During the years 1925, 1926, and 1927 rainfall has been abnormally great.

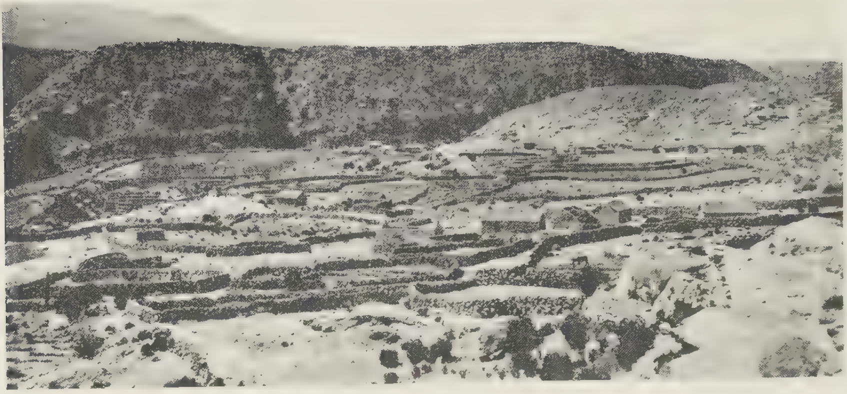

Fig. 26

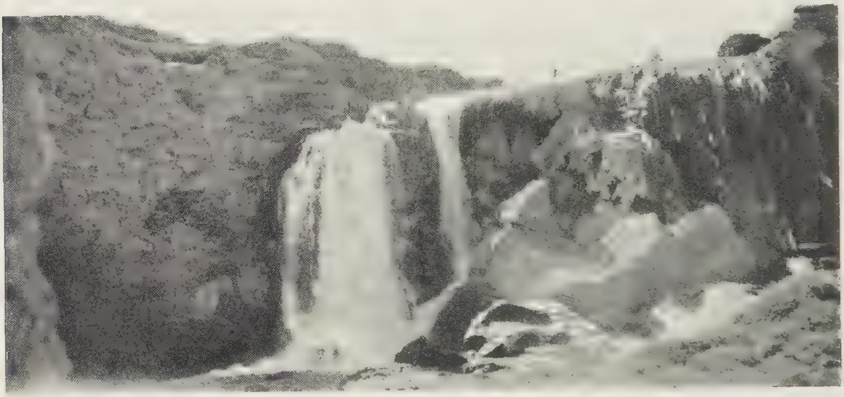

Fig. 27

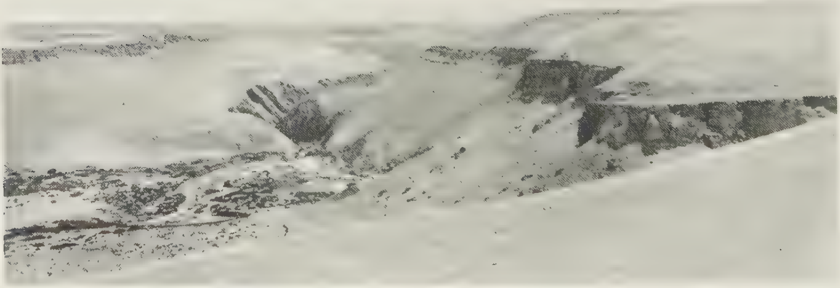

Fig. 28

Fig. 26—The pueblo of Toconce. The population is about 70.
Fig. 27—Falls of Chunchurie, Chintoraste.
Fig. 28—A wide spot in the Loa canyon below Quillagua.

Records of the Chilean Government covering the years 1917 and 1918 show annual evaporation of 128.0 and 106.3 inches respectively at San Pedro and of 182.5 and 179.5 inches at Chacance. The same records report 113.4 inches at Calama and 119.0 inches at Quillagua during the year 1917. Observations at Chuquicamata, at intervals between 1917 and 1927, indicate an average of 144 inches per year. These figures are interesting as a basis for comparison between the aridity of the Atacama Desert and that of other deserts of the world. Observations conducted by the United States Bureau of Reclamation to determine rates of evaporation on reclamation projects[15] showed an average mean evaporation of 122.81 inches per year at Yuma Citrus station over a period of three years of record. The maximum annual evaporation observed at this station, for the year 1921, was 135.70 inches. The next highest rate observed was at Elephant Butte, N. Mex., which was 109.70 inches per year.

Chacance and Chuquicamata are fairly representative of the arid sections of the Rio Loa basin. The stations at Calama and Quillagua were situated within cultivated areas, where relative humidity is high. The San Pedro observations apply to the more humid sections of the Loa basin, although even there evaporation is nearly as great as the average at Yuma.

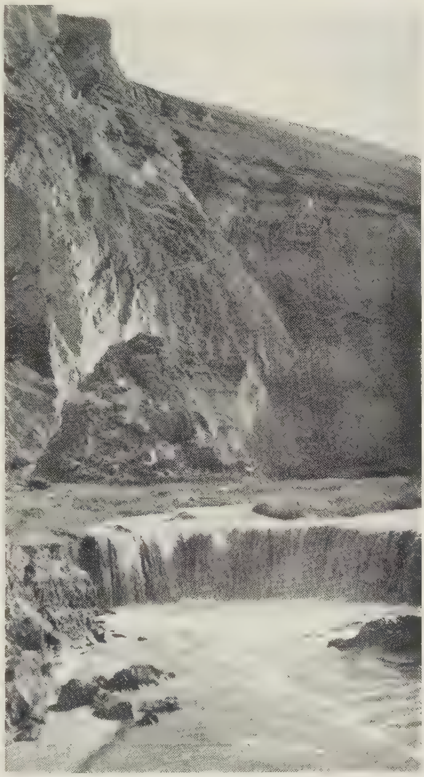

FIG. 29—One of a number of cascades occurring in the Loa between Calate and the mouth. Their configuration was greatly changed during the floods of 1925.

A comparison of the factors which influence the evaporation rates in the Colorado River valley and the Atacama deserts is also interesting. At Yuma Citrus station, situated upon a desert mesa eight miles southwest of Yuma, mean temperature was observed at 70.7° F., whereas at no point in the Loa basin is the average so high. At Calama, 7400 feet, it is about 57° F. Mean wind velocity at the Yuma station was 3.03 miles per hour, while that of the Loa region is generally much greater. At Chuquicamata, for instance, where mean temperature is about 58° F., wind velocity for the year September 1, 1925, to September 1, 1926, averaged 9.81 miles per hour.

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[15] I. E. Houk: Evaporation on United States Reclamation Projects, *Proc. Amer. Soc. of Civil Engineers*, January, 1926.

Our data on rainfall and evaporation in the drier portion of the Loa basin may be summed up in the statement that the precipitation of ten years is actually less than the evaporation of a single day.

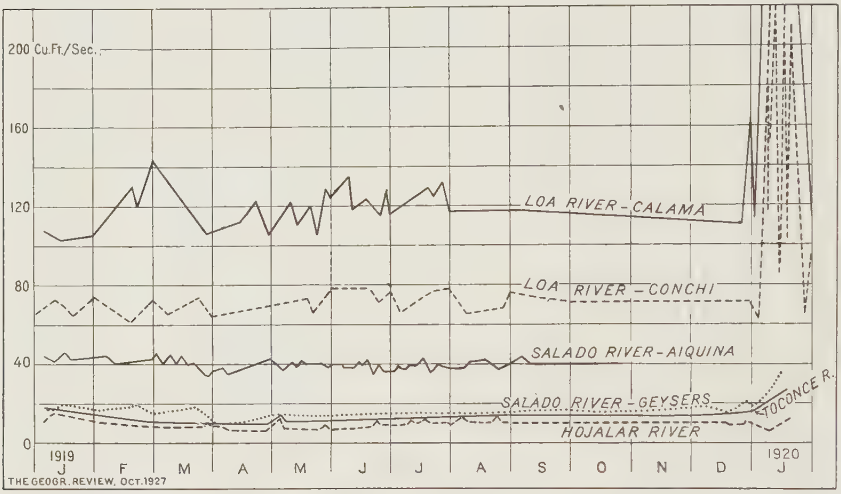

FIG. 30—Flow curves of Rio Loa and feeders from January 1, 1919, to January 31, 1920.

FLOW OF THE LOA AND ITS VARIATIONS

Between the crescent of mountains comprising San Pedro, San Pablo, Inacaliri, Apagado, Linzor, Tocotocare, and the Cerros de Tatio, and a secondary range nearly parallel, in which are Panieri, Leon, Toconce, Copacoya, and the Cerros de Tuina, is a huge basin filled with gravel and sand to a height of perhaps two thousand feet. Water is impounded within these sediments. Thus an immense reservoir is established at the very sources of the river, from which the water emerges as springs at the lower elevations along the inside range. This storage basin regulates the flow in the upper tributaries of the Loa, so that it is fairly constant throughout day, season, and year. The mean flow of the Loa at its maximum stage is 130.6 cubic feet per second, and of this amount 67.0 cubic feet per second ordinarily reach the sea (see Table II).

Flow in the streams at the head of the Loa is nevertheless somewhat higher during the late afternoon and night, because of increments from melting snows during six to eight hours of the day. Diurnal variation depends upon conditions at the heads of tributaries and is not likely to fluctuate more than from 15 to 20 per cent. There are also local variations due to the work of man. Irrigation is for

Table II—Rio Loa and Its Tributaries: Flow and Salinity

	Miles from Source	Elevation in Feet	Flow in Cu. Ft. per Sec.		In Parts per Million	
			Average	Normal	Cl	So_3
Rio Loa—Upper Section						
At Pozo del Miño	0	12,800	0.8		under 100	
At Ojos del Miño	2	12,713	8.1		under 100	
At Rio Chela	19	11,860	above 11.7 below 17.0		about 100	
At Lequena	37	10,843	21.5	19.8	146	178
At Santa Barbara	57	9,810	45.9	35.3		
Rio San Pedro						
Siloli—at sources		14,163	12.4		35	10
San Pedro—at Santa Barbara		9,810	19.2	14.1	195	120
Rio Loa—Middle Section						
Below Rio San Pedro	57	9,810	65.1	55.0		
At Conchi	62	9,560	70.6	61.1		
Below Chiuchiu irrigation	86	8,215	60.0	49.4	403	144
Rio Salado and Feeders						
Toconce—at springs		13,287	14.0	13.5	62	50
Hojalar		13,878	10.6	10.0	over 1,500	
Salado—at geysers		14,167	14.8	14.0	4,201	48
Caspana		12,224	4.2	4.0	about 100	
Salado at Aiquina		9,580	45.9	37.1	over 1,500	
Salado at Chiuchiu		8,215	70.6	51.2	1,548	76
Rio Loa—Lower Section						
Below Rio Salado	86	8,215	130.6	109.5	1,126	115
At Yalquincha	104	7,871	123.6	102.4		
At Chintoraste	111	7,005	59.0	30.0	1,292	131
At Chacance	151	4,101	76.6	45.9		
San Salvador—at Chacance		4,101	26.0	22.2	1,996	264
Loa below Rio San Salvador	151	4,101	102.6	68.1		
At Quillagua (above irrigation)	206	2,733	84.8	45.9	2,088	288
At Quillagua (below irrigation)	210	2,500	70.6	30.0		
At Calate	231	1,877	81.9	51.0		
At Pacific Ocean*	252	0	67.0	36.0		

*Waters of Pacific Ocean near mouth contain 19,391 parts per million of chlorine and 2376 parts sulphuric acid radical.

the most part carried on during the daylight hours, causing the river to rise during the night by the return of water as well as the closing of the canals. Opposite variations are effected by hydro power stations in the lower sections, where the water is stored at night and passes through the turbines during the day.

On account of the wet season in the upper reaches of the Loa watershed, summer flow is somewhat higher than during the rest of the year. A second factor of seasonal variation is introduced by irrigation. The irrigating season is from September to March and uses up a considerable portion of the flow. Part of the water seeps back to the river, but from one-third to one-half is lost at each farming center.

THE SMALL ANNUAL VARIATION

While the summer is the season of rainfall, there have been years when there was scarcely any precipitation in the Cordillera. It might be expected that the Loa feeders would dry up altogether under such circumstances. This has not been the case.

The flow chart (Fig. 30) covers a year during which there was no appreciable precipitation. This year was so dry that by September the western flank of the frontier range was nearly devoid of snow. Nevertheless, observations during the winter months of 1919, when the diminution in the water supply would presumably be reflected, showed a flow nearly up to the average of previous years. Where did the water come from?

The lower portions of the Cordillera Occidental consist of uplifted stratified rocks reaching elevations of 14,000 feet. Above them have been thrust forth immense volcanic extrusions, forming a chain of mountains with peaks reaching altitudes as high as 20,000 feet. The Bolivian *altiplanicie*, lying between this range and the folded sedimentary rocks forming the Cordillera Oriental, is a region of enclosed drainage. Near the 22nd parallel of latitude the surface is divided into a number of pampas without outlet, each with a lake fed by waters from the surrounding mountains. Nearly all of these interior drainage basins are above 14,600 feet.

Referring to the map (Fig. 3), it may be noted that the Laguna Colorado,[16] the largest of these lakes, is situated just above the springs from which the rivers Toconce, Hojalar, and Salado rise, with only the frontier range intervening. Similarly, the lake called Aralaguna lies above the springs of the Rio Siloli, while the particularly wet salars of Ascotan, Carcote, and Ollagüe occupy similar locations with respect to the upper Loa. It is natural to assume that there is a subsurface flow along contacts of old and new formations. Such flows would derive their waters from the eastern slopes of the Cordillera Occidental, which experience no severe droughts. A constant supply of water is thus available for the Loa springs at all times.

Here it may be mentioned that there are indications that the valleys were continuous at one time, the entire Bolivian *altiplanicie*

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[16] See F. C. Walcott: An Expedition to the Laguna Colorada, Southern Bolivia, *Geogr. Rev.*, Vol. 15, 1925, pp. 345–366.

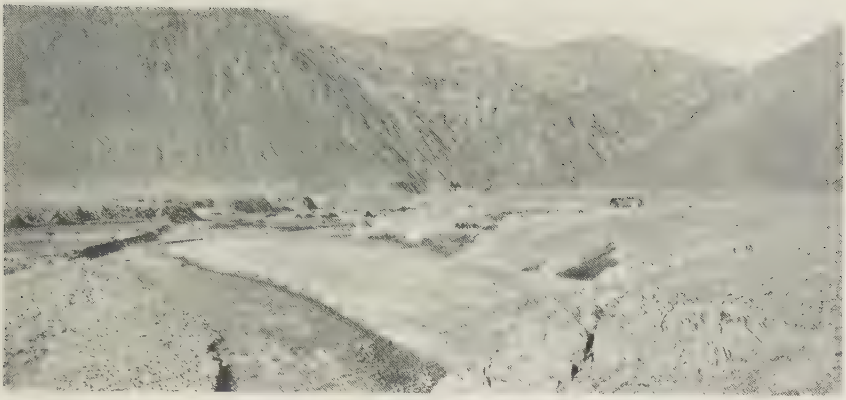

FIG. 31

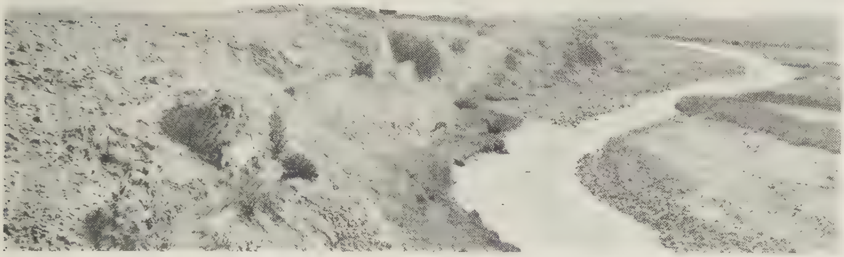

FIG. 32

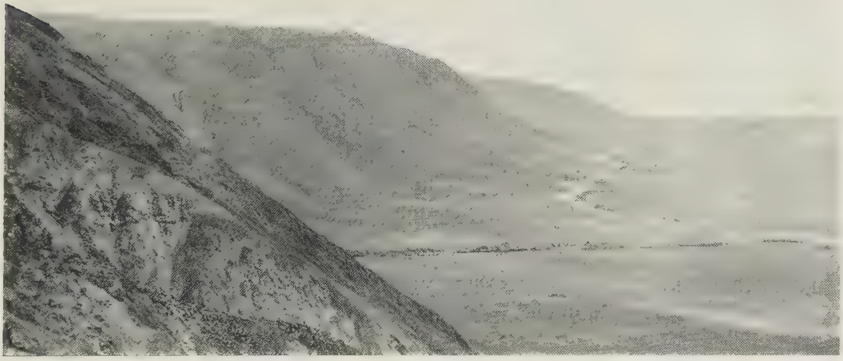

FIG. 33

FIG. 31—View toward the Coast Range from a point about one-quarter mile above mouth of Loa.

FIG. 32—View downstream from a point about one-half mile above mouth of Loa. The irrigation canal which had been used by present-day Changos prior to the floods of 1925 is slightly at the left of center, their shelter (see Fig. 5) in rear.

FIG. 33—The mouth of the Rio Loa, as seen from the trail descending the coastal escarpment.

Table III—Rio Loa: Rainfall and Flood Observations One-half Mile below Confluence with Rio Salado, Jan. 1 to Feb. 15, 1925

Jan. 1 to 25 . .	Maximum flow of river 93 cu. ft. per sec., minimum 83 cu. ft. per sec., latter occurring during afternoons owing to irrigation losses. River at abnormally low stage owing to 2 years of drought in the cordillera.
Jan. 26	Hard rain 3 to 9.30 p. m. (rain is most unusual at this place). River rose 4 ft. during night. After 4 hours of high water it dropped rapidly to 1 ft. above normal.
Jan. 27 to 30 . .	River 1 ft. above normal.
Jan. 31 to Feb. 1	River 6 inches above normal.
Feb. 2	Rain 4 p. m. to 10 p. m.
Feb. 3	Rain 5 p. m. to 7 p. m. River rising.
Feb. 4	Crest of flood at 4 a. m., river reaching 7 ft. above normal. Rain 5 p. m. to 7 p. m.
Feb. 5	Crest of flood at 4 a. m., river reaching 9 ft. above normal.
Feb. 8	Rain 5 p. m. to 6 p. m.
Feb. 9	Rain 5 p. m. to 6.30 p. m.
Feb. 10	Crest of flood at 4.30 a. m., river reaching 8 ft. above normal.
Feb. 11	Rain 5 p. m. to 7.30 p. m.
Feb. 12	Crest of flood at 2 a. m., river reaching 5 ft. above normal.
Feb. 13	Crest of flood at 4 a. m., river reaching 10 ft. above normal. Flow at crest of flood about 7250 cu. ft. per sec., most of the water coming from Rio Salado. Topography of river channel found to be completely changed after passing of flood.
Feb. 15	Crest of highest flood at early morning, river reaching 18 ft. above normal. Flow estimated at 15,072 cu. ft. per sec. by Kutter's formula but actually perhaps more. Flood came from both Salado and upper Loa. It destroyed bridge at Chiuchiu, and flooded streets of Calama.
	Rain 2 p. m. to 5.30 p. m.
General notes .	Crest of flood at early morning lasted only a few hours in each instance, water then dropping to within 1 or 2 ft. above normal flow. There were also small rises each afternoon during the rain period, beginning about 4 p. m. and reaching about 3 ft. 6 in. above normal.

draining into the Pacific Ocean through the Loa. At present Lake Titicaca flows to Lake Poopo, which in turn feeds a small amount of water to the Salar de Coipasa. Farther south are other salares, a series of evaporating pans separated from the upper course of the Loa by a single volcanic range. It is well within the realm of probability that prior to the extrusion of volcanic materials which increased the height of the Cordillera Occidental just east of the northern sources of the Loa, a drainage channel extended from lake Titicaca southward into the Loa. Springs which exist along the eastern side of the Loa canyon in this section indicate that some water is still flowing this way. When the egress in a southerly or southwesterly direction was disturbed, a large lake would have been formed, covering much of the *altiplanicie*. The overflow from this lake may have cut through the eastern Cordillera at the La Paz gorge to enter the Amazon system. It is recognized that immense lakes covered the high plateau during certain stages in geologic history[17] as a result of the glaciers which blocked the outlet toward the east at the gorge of the La Paz River. Such lakes should not be confused with the one which I suggest as having been caused by the volcanic dam at the southwest, the latter having been formed at an earlier time, although after the Andean region had attained much of its elevation.

FLOODS

Floods occur in the Loa during each period of heavy rainfall. The impermeability of the rock walls which enclose its feeders, as well as the stream slopes, are such as to lend little facility to escape of water to underground reservoirs, except those at the uttermost reaches of the system. Torrential rains have occurred in the Loa basin at odd intervals. The last was in 1925, this being contemporaneous with the supplanting of the cold north-bound Humboldt Current along the coasts of Peru and Chile by El Niño, a warm stream flowing south.[18] It is likely that the floods of 1925 were the greatest in the recent history of the Loa. The writer had had occasion to study river flow during the latter part of 1924, and to that end established a current-meter station a short distance below the Salado confluence near Chiuchiu. Inspection of the walls of the canyon to determine river heights during earlier floods disclosed driftwood and débris at points 8 feet above river level. Oldest inhabitants of Chiuchiu had no recollection of the water rising above that level. Notes of the observer at the measuring station (Table III) form a unique record to be added to the written chronicles of rainfall and floods of the Atacama Desert. Other changes caused by these floods may be noted throughout the lower course of the river. At the pumping station near Toco the stream adopted a new course with water level now 15 feet lower than formerly. The operator of this station stated that, whereas the water had been generally clear prior to 1925, there had been mud and sediment through the two years following the floods, resulting in continued trouble at the distilling plant.

SALINITY

Reference has already been made to the brackish quality of the Loa waters. In general it may be said that there is increase in salt content throughout the entire course of the Loa from the Ojos del Miño to the mouth. At no point is there a tributary received containing less of chlorides and sulphates than the main stream itself at the point of junction. Then there is the constant evaporation, though this is apt to be overestimated. Between Chacance and the mouth of the Loa, a distance of 101 miles, the toll of evaporation from the river, not considering that in the Quillagua farming district, is hardly more than one cubic foot per second, less than two per cent of the volume flowing between the two points.

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[17] A. G. Ogilvie: Geography of the Central Andes, *Amer. Geogr. Soc. Map of Hispanic America Publ. No. 1*, New York, 1922.

[18] R. C. Murphy: Oceanic and Climatic Phenomena Along the West Coast of South America during 1925, *Geogr. Rev.*, Vol. 16, 1926, pp. 26–54.

According to standards of the Chilean Government good water for irrigation should not exceed 200 parts per million in chlorine content. Actually the only farming districts in the entire Loa basin which have such waters are those of Santa Barbara, Toconce, and Caspana. Even at Chiuchiu, chlorine is double the percentage stipulated, although good crops of some vegetables are raised. Above the Salado confluence, all waters of the Loa are fit to drink, although those of the Rio San Pedro have a mild purgative effect. Below this point no water is used for drinking except where evaporators have been installed. In Calama, where chlorine content is more than six times the tolerance, only alfalfa and corn are grown. Even so cultivation exists at Quillagua, where the salt content is over ten times the figure set by the Chilean government.

The composition of the saline matter in the Loa is very different from that of ordinary river waters, rather resembling that of ocean waters.[19] It is believed that the soluble matter of the Loa is in a large part derived from volcanic sources, through the decomposition of tuff by waters charged with fumarolic products. The theory has also been suggested that, in consideration of the geologic history of the region, not all the salts are of such origin. As the Desert of Atacama emerged from the Cretaceous sea, a vast amount of saline matter must have crystallized out in shrinking basins, later to be uplifted and covered with igneous materials. Such unexposed beds may now exist to be traversed by the waters of hot springs on their way to the surface, particularly by those at the head of the Salado. The fact that the sodium chloride is so much greater than the aggregate of all the other salts of the Loa waters supports this theory.

Salt content of the waters throughout the basin is increased 50 per cent or more during the rainy season, by the dissolving of saline efflorescences by the rains that wash the grounds in the upper part of the basin.

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[19] Analysis of the semi-potable Loa waters at Lequena shows 31.5 per cent of the salt content to be sodium chloride, 17 per cent sodium sulphate, 14.5 per cent magnesium sulphate, 7 per cent calcium sulphate, and 19.5 per cent calcium carbonate. In the Salado, sodium chloride is the predominating salt, amounting to 80 per cent of the total salinity; and, as it is the Salado that furnishes the major salt content of the Loa, sodium chloride forms the bulk of substances in solution in the main stream below the confluence.

Underground Waters

Surface conditions of the Atacama Desert are such as to favor subterranean flow of water. A mantle of porous sediments covers much of the ground to depths of about 100 to 200 feet, while below lie stratified rocks of the Mesozoic age which are not all impermeable.

But little investigation has thus far been made of these hidden waters in the Loa drainage basin. It is possible that they are far greater in amount than those flowing at the surface. Outcrops of the underground waters occur at various places throughout the region, those in the most arid parts often being waters of good quality. But the major portion of these waters disappear never to be seen again, doubtless reaching the sea through passages in the Mesozoic sedimentaries. Some of the subterranean flows have been exposed at the great fault along the coast, there being 62 springs of good water between the mouths of the Rio Loa and the Rio Copiapó listed by San Roman.[20] It does not follow, however, that all of these springs are derived from waters of the cordillera—for condensation from the *camanchacas* which form and dissipate upon the west side of the Coast Range may also be a source of supply.

The great porosity of some surfaces of the Desert of Atacama was shown when the writer had occasion to divert a stream of about 200 tons of water per day. The water directly disappeared into the ground, and after several months of such flow there was not even an appearance of dampness at an excavation 70 feet deep situated 500 feet farther down the valley.

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[20] San Roman, *op. cit.*, Vol. 3, pp. 115–123.

ISOLATED RACIAL GROUPS OF HUNGARY

Erdmann D. Beynon

IF the traveler to Hungary forsakes the usual haunts of tourists to wander into the more remote regions, he will discover, scattered over Hungary and even beyond the borders of the present state, a number of secluded sections where inhabitants, though speaking only the Hungarian language, yet differ in a marked manner from the Magyars[1] around them in costume, dialect, and folk customs, while in each respect these groups show a remarkable similarity.

The problem of the origin of these remote groups is one that Hungarian ethnologists have struggled with for a long time. One thing is certain: they have absolutely no racial connection with the Germanic, Slavic, or other peoples with which the Hungarians have for many centuries been surrounded. They differ in certain respects from other Hungarians; yet in these very matters of costume, dialect, and folk customs the mass of the Magyar people shows far more decidedly the influence of neighboring peoples than does the population of these sections. One of the most notable features of their dialects is the absence of loan words which occur in great abundance in the speech of modern Hungary. I myself have had experience of the reality of dialectic differences during the course of my church work among Hungarians. My church has a constituency of about two thousand, Hungarians from every section of the home country. So long as they speak in ordinary Hungarian they understand each other: how many tell me they cannot comprehend the speech of Göcsej or Sárköz or Mezőkövesd! Szinnyei József's "Dictionary of Dialect," it may be noted, deals largely with the dialects of these isolated groups. Historical documents also confirm the racial differentiation of the groups.

The people of these sections usually claim with pride that they alone are pure-blooded descendants of the ancestral Magyars and that they alone have preserved the ancient manners of the race; ethnologists formerly assented to this view, supposing that seclusion had preserved the ancestral speech and customs.[2] During the last quarter of the nineteenth century and the first years of the twentieth a strong school of ethnologists has arisen in Hungary who hold that, though isolation doubtless favored the retention of ancient characteristics, close study of the case warrants no other conclusion than that these groups represent broken fragments of non-Magyar but related peoples. Where the seclusion was not sufficient, as in the case of the Kunok and Jászok of the Alföld, the ancient racial characteristics disappeared and the tribes became completely merged in the Magyar population around them. There are, however, many other secluded regions as, for example, the valley of the Tarna in the county of Heves, whose inhabitants differ in no way from the ordinary Magyar people. The striking difference is observable only in those sections in which racial non-identity has been made more pronounced through long seclusion. One of the greatest difficulties in the study of Hungarian folklore is that the separate origin of much of the folklore of these detached regions has not yet been sufficiently recognized.

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[1] For the purpose of this article it is necessary to make a distinction between the descendants of the Home Taking Magyars and the mass of people who today call themselves "Magyarok." Thus the people of every one of the isolated groups referred to consider themselves "Magyarok," although none of these groups is descended from the Magyars of the Invasion. To make this distinction more clear I shall take the liberty of using the native term, Magyars, only in reference to the seven tribes that entered Hungary at the time of the Invasion and to their descendants. I shall use the English term, Hungarian, in the wide sense in which it denotes all, whether of Magyar ancestry or not, who have become a part of the Hungarian people as we find them today. Thus these isolated groups may be referred to as Hungarian but not Magyar.

THE SÁRKÖZ[3]

In the County of Tolna, between the mountain of Szekszárd and the Danube, just across from Baja there lies a large level tract of exceedingly rich soil, the territory of the four villages of Öcsény, Decs, Sárpilis, and Alsónyék. The fertile land from which these villagers today reap abundant harvests was only a few decades ago a great swamp, from which the region derived its name of Sárköz—Country of Mud. The hard struggle for existence in those days compelled the men of the villages to remain absent from home a great part of the year, during which time they either fished along the shallow water-courses of the marshland or else sought pasturage for their herds and flocks on the banks of the swamps. The women remained at home in the little villages, which were set as islands in the waste of swamp.

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[2] A good example of the old viewpoint is Résö Ensel Sándor's "Magyarországi Népszokások," which was published in Pest in 1867. Interesting customs from all sections of the country are collected and treated as due in all cases to isolation. Ipolyi Arnold, in his "Magyar Mythologia," published in Pest in 1854, takes no account of the racial difference back of the customs of certain sections. Even Kandra Kabos, in his "Magyar Methologia," published at Eger in 1897, assumes that the customs of all the isolated regions are genuine Magyar customs and that isolation alone led certain sections to preserve the old customs.

The newer view, as set forth in this article, was first brought forward by Hunfalvy Pál, in his "Magyarország Ethnographiája," published in Budapest in 1876. That book revolutionized Hungarian ethnological thought in many ways, not least in its insistence on the place that the Besenyők, Kunok, Tatárok, etc. occupied in the composition of the Hungarian people. Since Hunfalvy's day different ethnologists have made detailed studies of the different isolated groups. Their works will be referred to in connection with the groups they studied.

[3] The most valuable work on the ethnology of the Sárköz is Malonyay Dezsö's "Magyar Nép Müvészete," Vol. 4, 1912, pp. 53–94. The poet Garay János was born in the neighboring city of Szekszárd. He has left an interesting account of the Sárköz in the olden days, Vol. 5, 1887, pp. 259–262. I myself was a guest at the home of Rev. Szilágyi Béla, Reformed Church pastor of Öcsény, and am acquainted with Rev. Szappanos Gyula, Reformed Church pastor of Alsónyék. From these clergymen as well as from the people themselves I learned of many customs not mentioned in the books referred to.

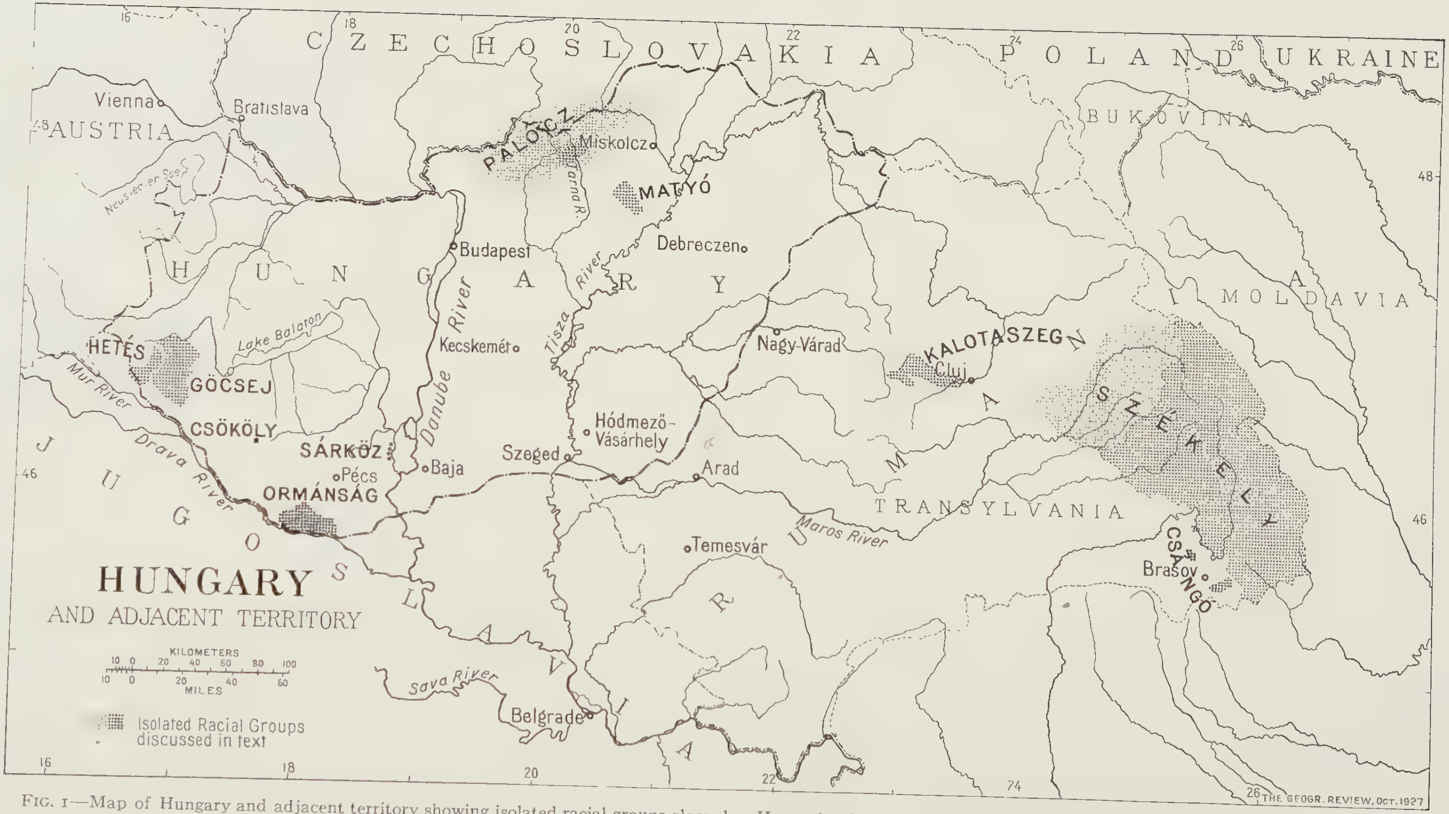

FIG. 1—Map of Hungary and adjacent territory showing isolated racial groups classed as Hungarian but of non-Magyar though related origins. (For a general ethnic map of pre-war Hungary see the series by B. C. Wallis in the *Geogr. Rev.*, Vol. 6, 1918.) The boundaries of present-day Hungary are shown in a heavy dot-and-dash line; the former boundaries in a line of fine dashes.

The area occupied by Palócz people cannot be exactly defined. Their characteristics are best exhibited in the area of more intense shading (Pétérvásári district of Heves county): on the east, i. e. on the western slopes of the Bükk Mountains the people are known by the name of Barkó, but they are generally identified with the Palócz. The Székely are less numerous in Maros Torda county (lighter shading) than in the other three Transylvanian counties they occupy. Scale of map approximately 1 : 5,000,000.

Being left alone, they developed to an abnormal extent two of the tendencies found among the women of all these remote sections: the tendency, on the one hand, to find employment in the weaving and embroidering of beautiful folk costumes for themselves, and, on the other, to seek social life in clubs or guilds, each composed entirely of girls or women of a particular age.

Since the marshes have been drained and transformed from a worthless waste into land of almost incredible fertility, these people have suddenly found themselves the richest villagers in all Hungary; yet in spite of the changed conditions many of the old habits of life remain. As in the days when their husbands were occupied with fishing or herding, the women even now do little work other than the embroidering of their costumes. The only difference is that they are rich now and can afford to buy the most expensive materials. When Malonyay Dezsö studied these villages in 1912, he found that the average girl's costume was worth 600–800 gold korona, i.e. $120–$160.[4] When I visited these villages in 1925, I was told by many of the people that an average girl's costume costs now at least the equivalent of $300 and that every girl of well-to-do family possesses several costumes. In spite of the increased costliness of the materials used, the same folk motifs are embroidered on the silk of today as were worked into the homespun of two or three generations ago. When the village women deck themselves out in their finest array and assemble in front of the Reformed Church on Sunday morning—all the people of the Sárköz are stanch Calvinists—the effect is almost indescribably beautiful. Malonyay compared it to a flower garden in which red and lilac colored flowers predominated against a green background: the silk dresses are very often green, and the embroidery shows almost every conceivable shade of red and mauve. Scattered among the bright colors are dresses of pure white; for white is the color of mourning in the Sárköz, just as it is in Csököly and the Ormánság.[5] My own impression of the distinctive quality of the dresses worn in the Sárköz is that, while the colors are bright, yet there is no such sharp contrast as in the color scheme of the dresses of Mezőkövesd. There is here a softer and more harmonious blending.

Several customs are connected with the wearing of these costumes, many of them not limited to the Sárköz but more or less prevalent through all these detached groups and even beyond them. Such a custom is that whereby a woman shows her family's wealth and importance by the number of petticoats she wears under her gloriously embroidered apron. Very often from thirteen to seventeen petticoats are worn, and the wearer is able only with great difficulty to enter the church door. The headdress of a woman indicates her condition, and the color of her clothes her age. There is a particular headdress—the *párta*—formerly with seven horns, to indicate the unmarried woman. Another headdress is substituted for this on the morning after her wedding. After the birth of her first child, her headdress is again changed. As the woman grows older she abandons more and more the gorgeous clothes of her girlhood. At forty she wears only white: at fifty only black. Yet in her coffin she is able once again to wear her bridal costume.[6]

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[4] Malonyay Dezsö: Magyar Nép Müvészete, Vol. 4, p. 79.

[5] *Ibid.*, p. 58.

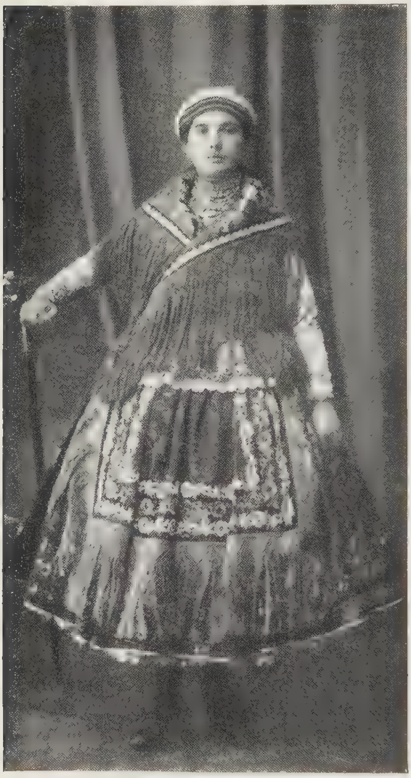

FIG. 2—Young woman of the Sárköz from Alsónyék in bridal attire.

A peculiarity of several of the Sárköz customs is the exclusion of men from the social group. Every girl becomes a member of one of the village bands, consisting of from fifteen to twenty girls under a recognized leader. Together they attend school; together they attend church on Sunday morning; together they take part in the peculiar dance in which no man is allowed to participate.[7] After the birth of a child to a young married member of the band the somewhat mysterious custom of *csöröglö* is held: this is a sort of baptismal rite, wholly pagan in character and handed down from pre-Christian times.[8] At the *csöröglö* only women may be present. After the rite some one is sent to announce to the father the birth of his child, just as in the old days when he would be far absent with his flock or fishing boat or be engaged in dressing the vineyard on the mountain side, and it is only after this announcement that the father is allowed to see his child. Another ancient custom is that of the *istenfa*—God's Tree—usually a rosemary shrub set out in the courtyard of each home. Before the woman of the house greets male visitors, she walks around the *istenfa* in order to secure protection from evil spirits.[9]

Some of the old customs have now been dropped altogether. No longer do the youths chase the maidens through the vineyards and become betrothed to the one they are able to catch.[10] Today marriage among these people is almost entirely a property consideration, worked out by the families of the prospective parties with a view to the enlarging of their estates. With a similar ambition before them the people have adopted the practice of birth control and limit the number of their offspring strictly to one child in the family.[11] The worst effects of a rigorous birth control are perhaps more manifest in the Sárköz and in the neighboring Reformed Church communities of Csököly and the Ormánság than anywhere else in the world. The few children are usually very delicate; and most students of the situation predict that, though there are still between eight and nine thousand of these interesting people, in a few more decades they will be entirely extinct. There are not as many of them today as in 1720, when their ancestors were serfs on the domains of the Roman Catholic abbeys of Szekszárd and Bátaszék. Every traveler to these villages comments on the gloominess and desolation so discordant with the wealth of the villagers. Many houses are vacant: the families who lived in them have died out completely. Though the houses are large, the small family—grandparents, parents, and the only child—find one or two rooms at the back sufficient for them to live in. All the spacious front rooms are unoccupied save by spare beds which are never used and by wardrobes in which are kept the gorgeous costumes of the women. This same desolation is to be observed in an even more marked degree among the less wealthy vil-

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[6] *Ibid.*, p. 54.

[7] *Ibid.*, p. 59.

[8] *Ibid.*, pp. 70–72.

[9] *Ibid.*, p. 74.

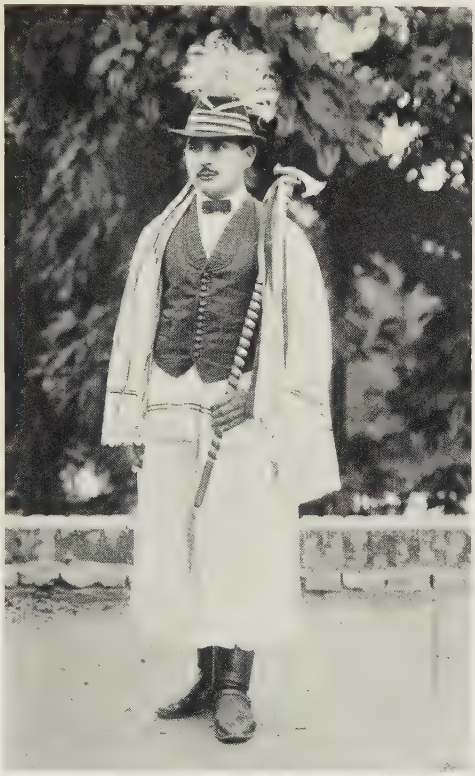

FIG. 3—Young man of the Sárköz from Öcsény in horse-boy costume.

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[10] *Ibid.*, pp. 68–70. See Garay János' account in the same work, Vol. 5, pp. 261–262.

[11] Malonyay Dezsö, *op. cit.*, Vol. 4, pp. 66–68. For the former population of the Sárköz see Daróczy Aladar: Tolna Vármegye Leirása, Vol. 1, 1909, pp. 39 ff.

lagers of the Ormánság and Csököly. As Mr. W. Stanley Lewis has suggested, the practice of birth control has been introduced through contact with Swabian settlers from South Germany. The pastor of Öcsény assured me it was due to the presence of South German office-holders who had been placed in the villages by the Austrian government after the collapse of the revolution of 1848.

A careful study of the people of the Sárköz along with an examination of the oldest documents relating to these villages shows almost conclusively that, in spite of their claim to be pure-blooded descendants of the ancestral Magyars, they are not Magyars at all but are descended from a tribe of Cumanians (Kunok) which joined the Magyars in the neighborhood of Kiev in those days before 896, when the Magyars under the leadership of Álmos and Árpád were marching toward the Carpathians and their present home.[12] These Cumanians were of an Ural-Altaic stock, closely related to the Magyars themselves. Unlike their kinsmen—Kunok and Jászok—who entered Hungary in the thirteenth century and occupied extensive tracts in the Great Plain or Alföld between the Danube and the Tisza and east of the latter river, these Cumanians who entered at the time of the Invasion have retained their ancient customs. Those of the Alföld, on the contrary, have become completely merged with the Magyar people around them. Only the names of their towns and villages indicate their separate origin. Doubtless it was the long isolation caused by the marshlands of the Sárköz which has preserved this distinctive type, while their kinsmen have completely lost their identity.

The Ormánság[13]

In the southwestern part of the county of Baranya, between the mountains of Siklós and the Drava River there is an extensive tract of level plain covered over with dense, almost primeval forests. In the clearings and farm lands scattered through these forests there are to be found the forty-four villages of the Ormánság. This does not mean that every inhabitant of these villages belongs to the distinctive group known as people of the Ormánság. Many are newer settlers who have occupied houses left desolate by the exercise of birth control to which reference has been made. Many again are servants on the estates of the great noblemen to whom most of the forests of this region belong. Hence out of a total population of 23,798 in 1900 (the census of 1920 gives 20,611) only 17,368 really belong to this ethnological group. The members of this group call one another "brethren" and distinguish them from other peoples by three signs—their

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[12] Malonyay Dezsö, *op. cit.*, Vol. 4, p. 72; Garay János, *ibid.*, Vol. 5, p. 260.

[13] The work of Lukácsy Imre, Reformed Church pastor of Diósviszló, entitled "Ormánság Népe," is invaluable. Though quite brief, only 28 pages, it gives all the needed information. Várady Ferencz: Baranya Multja és Jelenje, Vol. 1, 1896, pp. 170–218, is rhetorical and poetical rather than scientific.

Hungarian speech, their membership of the Reformed Church, and their wearing of the *kebel*, the distinctive dress of the Ormánság, a particular kind of white petticoat.[14]

The people of these forest villages have many peculiar customs. The very construction of their houses retains a reminder of the old nomadic days. The houses are not set firmly on the ground but on four rafts, as though to make it easier to move the *talpas ház*, as this is called, from place to place. The same type of house is found among the Székely people in Transylvania.[15]

The most interesting of the Ormánság customs is the *Alkudozás*—the bargaining which precedes the engagement of a young couple. In all Hungary a girl of marriageable age is called *eladó*, ready for sale, and in the Ormánság this expression takes on its full meaning. In the bargaining, the young folks themselves have least to say; in fact, the bargaining is usually done without even their knowledge. The representatives of the two families along with the broker or agent meet together and discuss the exact amount to be paid by the family of the bridegroom to that of the bride. Often a wedding contract is canceled because of a dispute over a thousand korona or an extra headdress. Even the minutest details are discussed at this conference, including the price to be paid by the wedding guests for the bride's kisses.[16] If a family have no sons, in similar fashion they buy a son-in-law, who is then known by the name of his father-in-law.[17]

Study of their customs leads one inevitably to the problem of the origin of the Ormánság. Though living just across the Drava River from Slavonia, their dialect has surprisingly few loan words of Slavic origin, and on account of the long Turkish occupation many Turkish traits are still to be met with. The very name, Ormánság, is derived from the Turkish word, *ormán*, meaning "forest"; but it is applied to this region in old documents antedating by centuries the Turkish occupation.[18] The women do not wear veils over their faces but cover them with shawls in the winter time, leaving only their eyes visible. They say that they do this to protect the skin, but a stranger would be certain that he saw Turkish women of the old régime. They paint their faces to make a sharper contrast with the white costume which they wear. Yet we know that the people of the Ormánság, as well as the name of their region, have a history that reaches back long before the Turkish period. It is now generally held that they are descendants of the Avars, a race which seized Pannonia after the overthrow of Attila's Hunnish Empire. We know very little about the Avars save that they were of Ural-Altaic stock, like the Huns and the Magyars, and that their dominion in Pannonia was short-lived and had melted away before the Magyar invasion of 896. It has been supposed that at the downfall of the Avar kingdom a great many of this somewhat mysterious race took refuge in the dense forests between the mountains and the marshes on the borders of the Drava River. They welcomed the coming of the Magyars, for they were their kinsmen, and the Magyars in turn left the people of Ormánság in possession of the land they had won from the forests.[19]

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[14] Lukácsy Imre: Ormánság Népe, p. 6. The usual meaning of the word *kebel* (also *kebél*) is bodice. In the Ormánság, however, but only there, it denotes a petticoat (see Luckácsy, p. 22).

[15] *Ibid.*, p. 16.

[16] *Ibid.*, pp. 24–25. This custom of marriage arrangement between the parents is by no means confined to the Ormánság any more than is the custom of showing wealth by the number of petticoats confined to the Sárköz, Ormánság, and Csököly. I have referred to these customs here because for some reason they have a prominence here greater than in most other places.

[17] *Ibid.*, p. 26. The custom of Vőszállitás has, so far as I know, few parallels elsewhere.

[18] Dr. Stefan von Györffy, Director and Custodian of the Ethnographical Division of the Hungarian National Museum, points out that there are three strata of Turkish loan words in the Hungarian language. The first, tenth century, is Bulgar-Turkish; the second, from the time of Arpád, is Kun-Bessenyö; the third is Osmanli-Turkish.

CSÖKÖLY[20]

The smallest of these isolated racial groups is that of Csököly, a village of 1615 inhabitants in the county of Somogy, not far from Kaposvár.[21] Like the people of the Sárköz and the Ormánság, the people of Csököly are stanch Calvinists; like those also they are a dying people because of birth control. In 1925 it was estimated that only sixty families of the old stock were left in the village. In one year there were three births and twenty-six deaths. The 43 young men from Csököly who died on the battle fields of the World War were all only children. The few children who are born now in the village are weak and sickly.

While many of the younger women are now abandoning their folk costume, that worn by the older women of Csököly is renowned throughout Hungary. White is the color for mourning: embroidery is allowed only on the headdress and the sleeves of the waist. Girls are married young in Csököly: at the time of my visit only three girls in the village had reached the age of 14 years without being married.[22] As in the Sárköz the tolling of the church bells indicates the sort of person who has died. For a man the bell is tolled 12 times at Csököly;

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[19] *Ibid.*, pp. 6–12. Rev. Mr. Lukácsy discusses very thoroughly in this place the origin of all the detached groups and the relationship between them. He quotes such high authorities as Dr. Sebestyén Gyula, formerly Curator of the National Museum of Budapest.

[20] There are other such isolated villages. I have dealt with Csököly because there is an excellent monograph on it by Gábos Dénes, "Csököly Község Monografiája" in the April, 1925, number of *A Falu*, the organ of the Faluszövetség, or Village Society of Hungary; and also because of its pronounced individuality. I myself lived for some time in the County of Somogy and was always told that Csököly was "very peculiar." A short description of Csököly is also to be found in Malonyay, *op. cit.*, Vol. 4, pp. 106-107.

[21] The neighboring village of Szenna, in the Kaposvári district of Somogy county has a great many points of similarity with Csököly. It, too, is a Reformed Church village with a population rapidly dying out because of birth control. Its costumes, however, as shown by Malonyay, *op. cit.*, Vol. 4, p. 115, show quite a divergence from those of Csököly. I know of no one who has yet made a special study of Szenna. Its population at present is reckoned to be 972, according to a census taken last year, although in 1919 it was said to have 1647 inhabitants.

[22] Gábos Dénes: Csököly Körség Monografiája, *A Falu*, Vol. 6, 1925, No. 4, p. 299.

for a woman only 10 times. Like the people of Göcsej those of Csököly retain pagan customs connected with the birch tree. On Good Friday they strike their pigs with birch wands so that they may escape hog cholera.[23]

The people of Csököly form a much later settlement than those of the Sárköz or the Ormánság. After the Tatar Invasion of 1241 during the reign of Béla IV, Hungary was almost completely destroyed. Early in the spring of the following year the Tatars retired, vanishing almost as suddenly as they had come. The Great Khan had died in his camp beyond the Volga, and the leaders, Batu and the others, hurried home to share in the spoils. Yet a few remnants of the great Tatar horde did not return with Batu Khan to Asia. They married Hungarian or other native women and settled down in isolated sections of Hungary. Such was almost certainly the origin of the people of Mezőkövesd and the Kalotaszeg. In the case of Csököly, it is generally held that the women whom the deserters from the Tatar horde married were probably Slovaks who had been left in this section by the conquering Hungarians. Whether that is so or not, the culture of Csököly shows no Slovak trace but retains much that is apparently of Tatar origin.[24]

GÖCSEJ AND HETÉS[25]

In the western part of the county of Zala, adjoining the Jugoslav frontier, is one of the largest in area of the isolated ethnological group regions of Hungary. The names Göcsej and Hetés have neither political nor historical significance: and it has never been satisfactorily explained why this region should thus be divided into two parts, since it forms an ethnological unit. Göcsej includes 89 villages. Immediately adjoining it on the west is Hetés with 17 villages. The villages are all small, the average number of inhabitants of a single village being about 550. The entire population of Göcsej is now about 53,000, and that of Hetés about 8600.[26] The eight western villages of Hetés were ceded to Yugoslavia by the Treaty of Trianon; with this exception the entire region still remains in Hungary.

Göcsej and Hetés do not derive their fame from the folk costumes worn by their people—though these are distinctive, they lack the beauty of the costumes of the Sárköz—but from their superstitions: they are known as the most superstitious regions of all Hungary. Every moment of the villager's life, from the cradle to the grave, every day of the year, every article of household furniture, every domestic animal, every phase of the agricultural life was and, in many sections, still is dominated by ancient pagan rites, customs, and beliefs, though the people consider themselves Christian—93 per cent of the people of Göcsej and 98 per cent of those of Hetés being Roman Catholics. In some villages they still retain the custom of walking nude around the house before dawn on Good Friday morning, in order that the evil spirits may not bother them throughout the year.[27] They put birch branches in their windows on St. George's Eve, because the birch was sacred to the old pagan goddess of the spring and they believe this will secure her protection from the powers of evil.[28]

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[23] *Ibid.*, p. 298.

[24] *Ibid.*, p. 297.

[25] For the regions of Göcsej and Hetés there is a book of outstanding value, Gönczi Ferencz: Göcsej, 1914. Its 689 pages are filled with the superstitions and folk customs of this interesting people: little information may be gleaned from any other book which is not to be found in Gönczi. Apart from some notices in Malonyay's work, Vol. 4, there is an interesting little book of Göcsej folk songs, selected by Abafi Lajos from Kőváry Béla's collection and published at Vácz in 1876. It is entitled "Göcseji Népdalok" and contains 214 songs along with an excellent introduction. In "Az Osztrák-Magyar Monarchia Irásban és Képben," Volume 4 of the Hungarian section, 1896, contains a description of the villages of Göcsej by Eötvös Károly. This description covers pages 235-248. Gönczi criticizes Eötvös as being unscientific.

[26] Gönczi Ferencz, *op. cit.*, pp. 19-29.

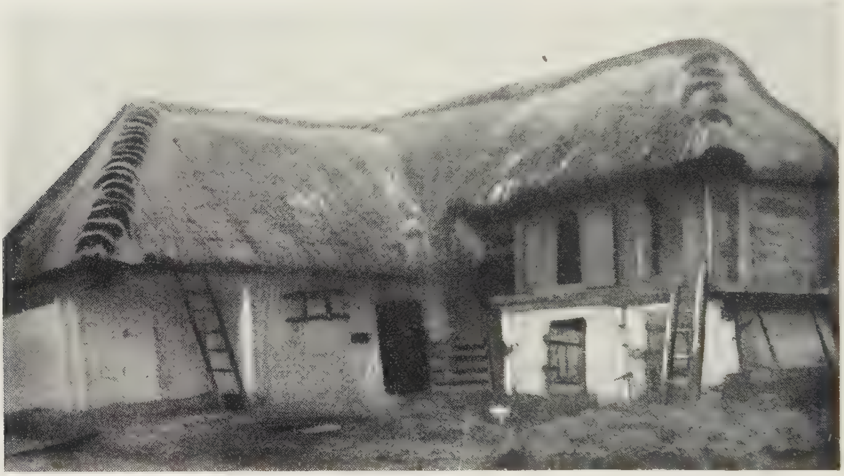

FIG. 4—A typical house in the Göcsej area, western Hungary.

The dialect of the people of Göcsej is quite different from ordinary Hungarian; some scholars go so far as to say that it is practically a distinct language.[29] Yet it has many similarities with the speech of the Ormánság. On the other hand, the striking likeness between the speech of Göcsej and that of the Székely people in the east of Transylvania has led many to believe that they are both branches of the same stock.

The most probable explanation of the origin of the people of Göcsej is that they are a mixed race—Avar and Besenyő.[30] After the defeat of the Avars by Charlemagne, many of them took refuge in the forests of this region as well as in those of the Ormánság. Later on the Besenyők or Petchenegs were settled among them and mixed with them. The coming of these Besenyők was very interesting. They were an Ural-Altaic people, kindred to both the Avars and the Magyars. They entered Moldavia during the closing years of the tenth century. King Stephen (reigned 1001–1038) was forced to engage in many struggles with them because of their inroads across the border into Transylvania. Finally, during the reigns of his successors the power of the Besenyők was broken because of stronger tribes attacking them from the rear, and they were glad to enter Hungary not as conquerers but as settlers. Many of this once warlike people were placed on the western frontier to ward off the encroachments of the Slavs. Here they amalgamated with the resident Avars, to form the present population of Göcsej and Hetés. Other colonies of the Besenyők were placed in little villages all over the country in sparsely populated parts such as were annually inundated by the Duna and the Tisza. In these scattered villages the Besenyők became completely fused with the Hungarian people about them. The only mark of the original colony is the name of Besenyő which still clings to most of these villages. One of the Besenyő villages, however, Besenyőtelek, in the county of Heves, still retains a great many of the old Besenyő beliefs.[31] In fact the folklore of the one isolated village is almost identical with that of Göcsej.

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[27] *Ibid.*, p. 243.

[28] *Ibid.*, p. 251.

[29] *Ibid.*, pp. 487–490. Torkos Sándor, Toldy Ferencz, Vass József, Kardos Albert are cited among others who hold this view.

[30] *Ibid.*, pp. 91–92. Gönczi here discusses the relationship among the Székely, Palócz, and Göcsej peoples.

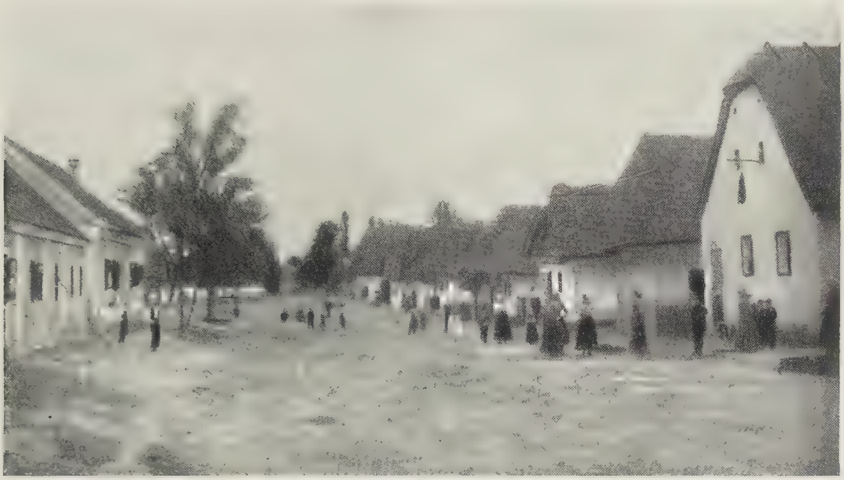

FIG. 5—A street in Landvavásárhely, Göcsej.

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[31] There is a good description of the ethnology of the village of Besenyőtelek in the introduction to Berze Magy János: Népmesék, Folk tales from the Counties of Heves and Jász-Nagykun-Szolnok, 1907.

THE PALÓCZ PEOPLE[32]

Of all the isolated racial groups of present Hungary the most numerous is the Palócz, whose settlements comprise a large part of the counties of Hont, Nógrád, Gömör, Heves, and Borsod and include at least 150 villages with a population of over 150,000 souls. The study of the Palócz people is more confusing than that of other racial groups in the country, because the Palócz people themselves are ashamed of their name and of anything in speech, costume, or habits which distinguishes them from the rest of the Hungarian people. The reason for this is probably the practice of both the Hungarian stage and the Hungarian people of treating the Palócz as Hungary's most ridiculous figure: every proverb which refers to the Palócz describes him either as a clown or a boorish backwoodsman. When the great Hungarian novelist, Mikszáth Kálmán, portrayed in a kindly way the amiable features of the Palócz character, the people of the little Palócz village where he lived began to take pride in the name which the rest of their race have considered a reproach. As a result of this attitude on the part of the people themselves it is very hard to define the exact limits of the region. Parád, in the county of Heves, is considered the center of the Palócz country, because its people exhibit most strongly the Palócz characteristics in dress, speech, and customs. Yet the people of Parád are very quick to deny that they are Palócz people at all.

The word Palócz is supposed to be a corruption of the Slavic word Polowetz, which means "robber," and was originally given by the surrounding Slav peoples to marauding bands of Cumanians who, setting out from their home in what is now Russia or Poland, poured through the passes of the Carpathians on the north and occupied this region either at the time of the Magyar Conquest or shortly before it. In ancient Russian hymns of the eleventh century we find the "Palowcok" described as a fierce race which lived on the Don, Dneiper, and Volga Rivers. Anonymus describes the union of Kunok with Árpád's people at Kiev and their settlement in Hungary. It was from these that the people of the Sárköz sprang. Documents from the time of King Zsigmond, (1387–1437) show that even at that date the Pálócz Kunok, as they were called, did not know how to speak Hungarian. Even farther back than that, when King Salomon warred with St. László in 1086, he sought assistance from the Palócz people.[33]

If this hypothesis of the origin of the Palócz is correct—and it is now generally accepted by Hungarian scholars—then there have been at least three distinct Cumanian (Kunok) settlements in Hungary: the earliest, that of the Palócz, coming from the north and completely distinct from the tide of Magyar invasion which soon followed it; the second, the small group of people found in the Sárköz, whose ancestors accompanied the invading Magyars; the third, coming from Moldavia where, after breaking the power of the Besenyők, they harassed Hungary for centuries but finally entered to settle in certain tracts in the Alföld set apart for them by the Hungarian kings. These Kunok of the Alföld, along with the kindred Jászok, preserve practically none of their primitive characteristics but have been assimilated to the Magyar people about them. Dr. Györffy, however, points out that before drainage and regulation of the flood lands, some 70 to 80 years ago, cattle were bred in the ancient manner by the Kun people.

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[32] The best description of the Palócz people is Malonyay, *op. cit.*, Vol. 5, 1922. In "Nógrád Vármegye Monographiája," 1911, pages 137–168 contain a good account of the Palócz people by Farkas Pál. In "Az Osztrák-Magyar Monarchia Irásban és Képben" there is in Volume 6 of the Hungarian section, 1900, a description of the Palócz people by Istvánffy Gyula. It covers pages 181–195. Istvánffy Gyula prepared two separate works, "Palócz Néprajzi Tanulmányok," 1894, and "Palócz Mesék a Fonóból," 1890. As showing the real Palócz character perhaps the best description is found in Mikszáth Kálmán's "A Jó Palóczok," 1915.

[33] Further data may be found in Malonyay, *op. cit.*, Vol. 5, pp. 12–14.

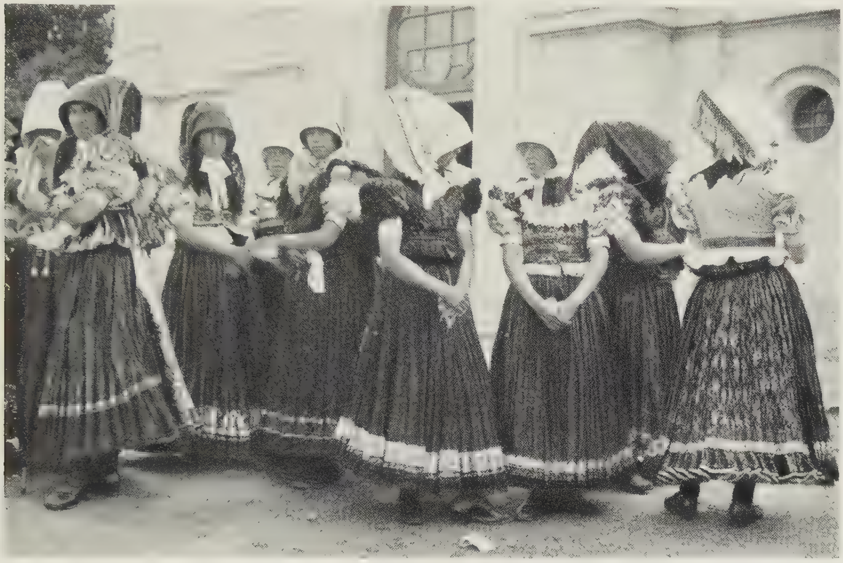

FIG. 6—Women of the Matyó. Young married women of Mezőkövesd, wearing the high-peaked *konty*.

THE MATYÓ PEOPLE[34]

In the southwestern corner of the county of Borsod lie the three communes of Mezőkövesd, Szent István, and Tard,[35] with a total Matyó population of about 23,560, of which about 17,800 are people of Mezőkövesd. Unlike the dying races of the Sárköz, the Ormánság, and the Csököly, the Matyó people are increasing faster than those of any other section of Hungary. The rapid increase has made it necessary for a large proportion of the people to seek their livelihood elsewhere during a great part of the year. As laborers they are employed on many of the extensive estates for the entire summer and autumn. Their travels, frequently from one end of the country to the other, bring them into close contact with every type of laborer in Hungary. Further, the Matyó people are devout Catholics and for the sake of pilgrimages will travel to any celebrated shrine in Hungary or beyond its borders. The handwork of the women of Mezőkövesd has become so widely renowned of late years that a market exists for it all over Europe; hence trade takes them as far as Vienna, Berlin, and Paris.

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[34] Istvánffy Gyula: A Matyó Nép Élete, 1897, gives a good description of the Matyó people, though I feel compelled to disagree with his view that they are merely a branch of the Palócz people. Garamszeghy Sándor: Matyo-lakodalom, gives a good outline of their wedding customs.

[35] The commune of Ecséd in the Hatvani district of Heves county is said by the people of neighboring villages to be Matyó. At present, however, there is no connection between this village and the three Matyó villages of Borsod county.

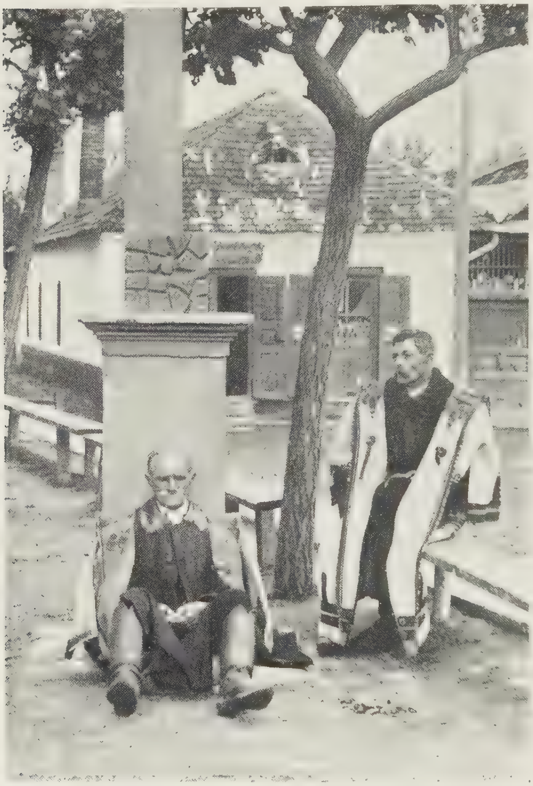

FIG. 7—Two old men of Mezőkövesd. A typical Matyó home in the background.

One would expect that this constant traveling and intercourse with other people would blot out the peculiar Matyó characteristics. On the contrary it seems merely to have intensified them. Wherever a Matyó travels, he associates only with other Matyó people. Matyó immigrants to our large American cities intermarry only with Matyós, even to the second and third generation. Though the Matyó does not retain his peculiar folk costume in America, still everywhere in Hungary he glories in the fact that he and his race dress differently from all other people. At the festival of St. Stephen in Budapest in 1925 I saw a group of a thousand Matyós all dressed in the ancient Matyó style. The most interesting thing about them was the pride with which they compared their own resplendent garments with the clothes of other people. In the same way they strive zealously to retain the old Matyó dialect: they do not wish to talk like ordinary

Hungarians. Childish as many of their old superstitions seem, they refuse to give them up, for are not these things also of the Matyó heritage? Thus their attitude contrasts with that of the Palócz.

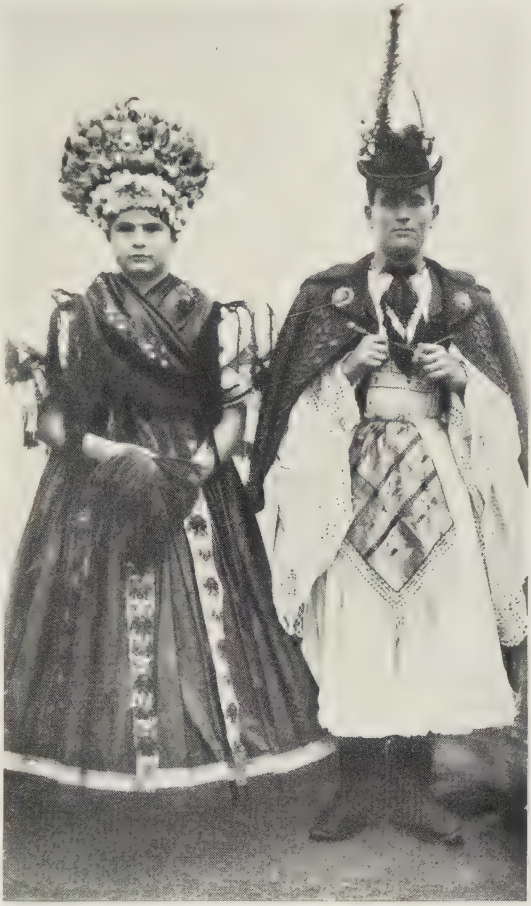

FIG. 8—A young married couple of Mezőkövesd.

The origin of the Matyó people has long been a disputed question among Hungarian scholars. They seem to have received the name of "Matyó" because they were, so they claim, the recipients of special favors from King Mátyás, who reigned from 1458 to 1490. Yet their history reaches back beyond his time. Some have argued that the Matyó people are a branch of the Palócz. In support of this they adduce the similarity between the Matyó and Palócz dialects and folk costumes. In the latter respect, however, the similarity is far from convincing. A careful investigation of the subject reveals a much more pronounced harmony with the Tatar groups—of Csököly and the Kalotaszeg—than with the Kun groups. Hence the most likely explanation of the origin of the Matyó people is that they are another broken remnant of the Tatar Invasion.[36]

THE KALOTASZEG[37]

The six groups so far studied are to be found almost entirely within present Hungary. A few villages of Hetés belong now to Jugoslavia, and the northern Palócz villages have been ceded to Czechoslovakia.

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[36] Istvánffy Gyula: A Matyó Nép Élete, pp. 119–122.
Idem: Az Osztrák-Magyar Monarchia, Vol. 6, p. 181.

[37] The best description of the Kalotaszeg is Malonyay, *op. cit.*, Vol. 1, 1907.

The three remaining groups are in Transylvania, Rumania, in territory entirely outside the borders of present Hungary. A part of one of these groups was even outside the borders of pre-war Hungary.

The Kalotaszeg is a region of 34 villages in the county of Kolozs (Rumanian, Cojocna) between Kolozsvár (Cluj) and Bánffyhunyad (Huedin). The people are descendants of Tatars but were settled in their present home by Prince George Rákóczi II about 1650.[38] They are stanch Protestants and resemble in many ways the people of the Sárköz. They employ much more color, however, in their folk costumes, for that seems to be a Tatar trait. Their dialect too is very similar to that of Csököly and the Matyó villages.

THE SZÉKELY PEOPLE[39]

The four southeastern counties of Transylvania are the home of the Székely race. While the Palócz group is the most numerous of present Hungary, it is relatively insignificant both in numbers and importance if compared with the Székely people. In the counties of Csik (Ciuc), Háromszék (Trei Scaune), Udvarhely (Odorheiu), and Maros Torda (Mures Turda) there are at least half a million of these people, a people not ashamed of their racial identity but glorying in it. Among all the Hungarian-speaking peoples there are no others so proud as these: this is partly due to the fact that this entire people was ennobled as a sort of peasant aristocracy. Although their possessions were small and they were compelled to work hard to eke out a living in rather barren country, still it was only for themselves that they worked. The ill effects of the feudal system in Hungary, with its sharp class distinction, were never found among them. The liberty-loving Székely could never tolerate either that he should serve others or that others should serve him. When tax-paying was the badge of serfdom, it became a proverb that the Székely would sooner die than pay taxes.

This proud race laid claim to descent from the heroes who fought under Attila. In poetic fashion they told how on the downfall of the great Hun Empire, a large body of the Huns remained in the Székely land, defending themselves from the enemies who surrounded them on all sides, while Csaba went back east—back to Asia—to summon their brethren, the Magyars, to assist them in winning back what had been lost. It is a romantic story, and the Székely people are very proud of it. Unfortunately historical documents are all against it but seem to show that the Hungarian kings of long ago set the Székely people on the eastern border that they might guard it at first from the Cumanians and later from the Rumanians. Hence their origin is very similar to that of the Göcsej people. At present it is generally assumed that the Székely people were of Besenyő origin, like those of Göcsej.[40] On the contrary, some scholars assert that the Székely dialect resembles more closely that of the Ormánság: hence an Avar origin is claimed. Might there not be some truth in the supposition of the people themselves that they are of Hunnish descent? This alone is proved: that the Székely people are not of Magyar ancestry but come of some closely related people.[41]

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[38] Wlislocki Henrik, in article "Kalotaszeg" in the Pallas Lexicon, Vol. 10, 1895, pp. 70–71. Dr. Jankó János in "Kalotaszeg Magyar Népe," one of the most valuable works on the region, takes the view that the Tatars settled here in the time of Rákóczi and mingled with the people previously living in these villages.

[39] For descriptions of the Székely people see Malonyay, *op. cit.*, Vol. 2, 1909, and "Az Osztrák-Magyar Monarchia Irásban és Kèpben," Hungarian section Vol. 7, 1901, pp. 261–279. This is written by Kozma Ferencz. See also Benedict de Jancsó: The Székelys, Budapest, 1921.

THE CSÁNGÓ PEOPLE[42]

The Csángós, who received their name from the peculiar sibilating manner in which they pronounced certain Hungarian consonants,[43] are a widely scattered people. Their chief home is in the county of Brassó (Brașov) where they occupy seven villages—Bacsfalu, Türkös, Csernátfalu, Hosszufalu, Tatrang, Zajzon, and Pürkerecs: it is from this location in seven villages that they are called the Hétfalusi Csángók. Three other villages—Apácza, Krizba, and Brassó Ujfalu—also claim to be Csángó. Probably the only basis for their claim is that they too are Hungarian-speaking Lutherans in the Saxon county of Brassó. The lot of these Csángós was a hard one. They were settled here as guardsmen for the wealthy Saxon burghers of Brassó. They were almost forcibly converted from the Catholic to the Lutheran faith. Everything was done to make Germans of them; in spite of all they retained rigidly their Hungarian nationality and their Csángó customs. There are today 12,000 of this race in the seven villages, and it does not seem that their continued existence is threatened by any of the evil practices which are now depopulating some of these isolated groups.

In the time of Queen Maria Theresa many of the Csángós as well as Székelys emigrated to Bukovina and Moldavia.[44] In Bukovina they founded another group of seven Csángó villages, those of Andrásfalva, Boldogfalva, Hadikfalva, Istenfogadj, Istensegits, Józseffalva, and Magyarfalva. A more interesting situation awaited the colonists to Moldavia. In many counties, but especially in those of Bacau and Roman they came into contact with other Csángós who had been in Moldavia for centuries. Owing to absorption in the Rumanian population which surrounded them these older Csángó inhabitants had very largely lost their distinctive character. Contact with the newer immigrants helped them to persist in retaining the distinctive customs and language of the Csángós. There are at present about 100,000 of these Csángós in Moldavia.[45]

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[40] Gönczi, *op. cit.*, pp. 91–92.

[41] Sebestyén Gyula, former curator of the National Museum, in the article "Székelyek Eredete," The origin of the Székely People, in the Pallas Lexicon, Vol. 15, 1897, pp. 520–522.

[42] There is a good article on the Csángó people in Malonyay, *op. cit.*, Vol. 2. The introduction to Horger Antal's "Hétfalusi Csángó Népmesék," 1908, is one of the most authoritative works on this people.

[43] Simonyi Zsigmond in the Pallas Lexicon, Vol. 4, 1893, p. 609, notes that in most respects the Csángós of Brassó County have a dialect very similar to that of Moldavia.

[44] Dr. Györffy points out that the origin of the Moldavian Csángós is not yet cleared up. There are traces of them even at the time when the country belonged to the Kuns with whom they mingled. Some probably fled thither in the fifteenth century as Hussites from near the Drava. Perhaps Maria Theresa settled the Csángós of Bukovina from Csik County.

It is only since the cession of Bukovina and Transylvania to Rumania that the entire Csángó race has come under a single imperium. While Rumanian rule is said to be very galling to the Székely people, it is not greatly disliked by the Csángós. Even before the war Hungarian writers who studied the Csángós of the county of Brassó said that they considered Bucharest as their capital rather than Budapest. Many passes lead to Rumania. People having horses and carts were gladly received and well paid in the Rumanian kingdom. It was to Bucharest that a great many of them went to earn their livelihood.[46]

The Csángós are probably the broken remnants of the old Cumanian principality which for centuries occupied what later became Moldavia. This explanation would account for their presence in Moldavia and also for the similarity between their speech and that of the peoples of Palócz and Sárköz.

The interesting fact that these nine related but distinct groups have preserved ancestral customs and habits far better than the Magyars themselves is paralleled by the story of the Rechabites in the Book of Jeremiah. Doubtless the Rechabites were a nomadic tribe which had accompanied Israel at the conquest of Canaan. Centuries afterward when the prophet Jeremiah wished to find an example of the good customs of bygone days, he had to turn to these Rechabites who had remained in all things just like their fathers. So is it with these isolated races of Hungary. In speech, customs, and folk costumes they have remained like their fathers. Though not themselves descendants of the invading Magyars, they show us better than do the Magyars themselves how the ancestral Magyars lived, talked, and dressed.

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[45] John Tatrosi: The Hungarians of Moldavia, p. 3.

[46] Malonyay comments in several places on this connection between the Csángó people and Bucharest. See also Horger, *op. cit.*, pp. 9-11.

CONTRASTS IN DAIRYING IN TWO DISSIMILAR AREAS OF THE UNITED STATES*

John Wesley Coulter

THE value of the peculiar contribution of geography to the solution of such problems as those discussed in this study of "environmental responses" lies in its treatment of the relationships existing between the difficulties of the people and the conditions under which they earn a living. Probably most geographers will agree that one of the objectives of economic geography is that of helping man to occupy successfully the difficult places of the earth by pointing out the lines along which adjustments should be made if he is to reap the full reward of his endeavor.

The present status of the dairying industry in the two contrasted areas under discussion has come about largely as the result of environmental factors, and the future course of development in each case must be along lines of adaptation to physical conditions, a knowledge of which is indispensable to a proper understanding of the situation. One of these contrasted areas is the coast district of San Luis Obispo County, southern California, and the other is Cook County, Illinois.

Climate and Feed

In the dairy-farming district along the coast of San Luis Obispo County natural pasturage is the main feed. The climate of this district, as of most of California, is one of winter rain and summer drought (Fig. 1). Vegetation grows luxuriantly during the rainy season and for a short period after its close: moisture rather than temperature is here the critical factor in plant growth. The mean seasonal precipitation at San Luis Obispo is about twenty-one inches, most of which comes between the beginning of December and the end of March. By midsummer the grass has dried up. The dry air and bright sunshine so effectually cure the pasturage that it preserves its nourishing qualities with little or no impairment, though the landscape becomes parched and brown. Most farmers grow enough oat hay to feed their cows for a few days before and after calving, because cows heavy with calf cannot forage successfully in the hilly country of this district (Fig. 2). Barley hay is raised as feed for horses. The oats and barley are sown on flat areas among the hills soon after the rainy season sets in, so that all available moisture may be turned to advantage. The tilled land on dairy farms is from one-seventh to one-tenth that devoted to natural pasture. Harvesting takes place from about the middle of July to the middle of August; there are no summer rains to interfere with operations. Some farmers thresh part of their grain, using a combined reaper and harvester to cut and thresh it in a single operation. This combination is possible because the grain has been perfectly dried. Only the heads are cut off; cattle graze on the stubble. In most cases the grain is ground or rolled in a mill on the farm. There are a few dairy farms in this district on which a little alfalfa is raised by irrigation. Part of the land of these farms is on the flood plains of small creeks, from which water for irrigation is obtained by means of diversion dams or pumps. Within the last two or three years several dairymen have raised corn for ensilage, and it has been shown that this can be done without irrigation. The frequent occurrence of dense summer fogs along the coast helps to make this possible by inhibiting the evaporation of the abundant supply of moisture accumulated in the ground during the rainy season; unusually heavy fogs contribute moisture directly.

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*The writer wishes to acknowledge courtesies extended by Mr. Parker Talbot, Farm Adviser, San Luis Obispo County, California, and by Mr. L. L. Heller, Farm Adviser, Cook County, Illinois, during field work in these areas.

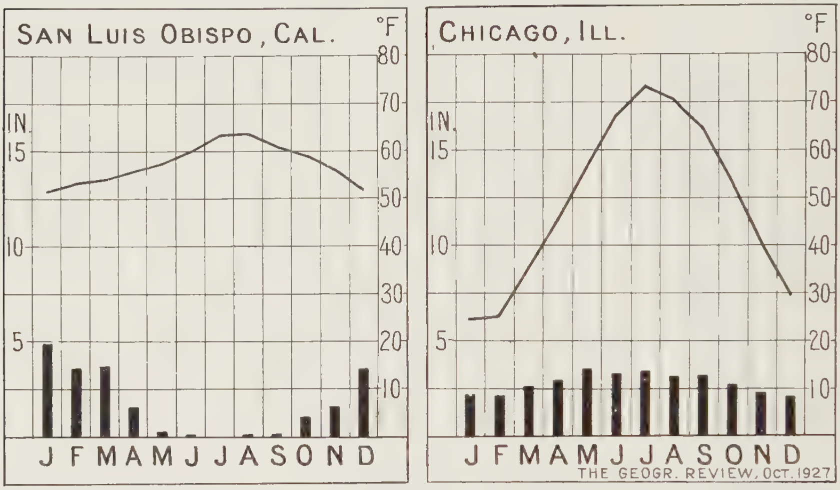

FIG. 1—Graphs of mean monthly temperature and rainfall at San Luis Obispo, Cal., and Chicago, Ill.

In Cook County, Illinois, fodder for dairy cattle consists for the most part of alfalfa hay, clover hay, and corn ensilage. Two crops of alfalfa are raised from the same seed without any moisture except that provided by the rainfall, much of which comes during the summer (Fig. 1). Temperature conditions, rather than moisture, here limit the growing season, which is about five months long. Snow commonly covers the ground much of the time during the months of January, February, and March. More work is required to harvest hay in the continental climate of Cook County than in the dry, subtropical climate of San Luis Obispo County. Corn is raised in Cook County under conditions approaching optimum. Copious summer showers interrupt bright sunny weather. Temperatures both by day and by night are relatively high during the period of rapid growth of the corn plant. The land is slightly rolling, and much of the soil is rich. Farms are artificially drained, so that excessive moisture is carried off promptly. On 9 to 10 acres of land sufficient corn is raised to fill a silo of 100 tons capacity. A regular rotation of crops is practiced.

TYPE OF COW

The San Luis Obispo cattle are small and agile, able to climb about on the hilly pasture lands—in places very steep and rough. They can live for a time on a severely restricted amount of food and so are likely to survive an occasional shortage of grass due to an abnormally low rainfall or an unusually long dry season. Though the rough-coated "scrubs" having the foregoing characteristics yield relatively little milk and in many places would be regarded as inferior animals, dairymen here assert that they are the best kind to keep on these lands under present methods.

In Cook County 90 per cent of the dairy cattle either are Holsteins or have a predominating strain of Holstein blood. The Holstein breed originated in a region where a cool and moist climate induces a luxuriant growth of grass with a high percentage of water but a low percentage of nutritive value.[1] Holsteins give a larger quantity of milk than other improved dairy breeds, but the milk is relatively low in percentage of butter fat and in other solids.

FARM AND BUILDINGS

The average size of a dairy farm on the coast district of San Luis Obispo County is about 750 acres, which commonly will support about 75 dairy cows. The land is divided into separate fields by barbed wire fences. The day field is the largest grazing unit, and it comprises 300 to 400 acres. As a matter of convenience the night field, of 40 to 50 acres, is in most cases nearer to the dwelling house then the day field, preferably on relatively smooth land. Dairy cattle are outdoors the year round; and on cold, dark mornings of the rainy season it is specially desirable to be able to corral them easily and quickly. The "back field," of about 200 acres is farthest from the house; this is where heifers graze, and horses also graze there when not in regular use. A small field for cows about to calve is located within easy reach of hay. The hay and grain fields occupy 75 to 100 acres of land that is nearly level and on which machinery can be used. The remaining tilled land on a farm is a small garden and orchard.

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[1] V. C. Finch and O. E. Baker: Geography of the World's Agriculture, Government Printing Office, Washington, 1917, p. 119.

A dairy farm in Cook County comprises about 100 to 150 acres. On a 100-acre farm one would find that about 25 acres are used to raise corn, 30 acres for alfalfa or clover, and most of the remainder for pasture or grain. The number of dairy cows ranges from 20 to 30. They are kept in the barn during the winter and early spring, except for an hour or two each day. They also are driven in at night during cold weather at other times of year.

On a dairy farm in San Luis Obispo County the cow barn is the most conspicuous building (Fig. 2). The predominant type of horse barn is what is known locally as a "California barn," whose characteristic feature is its "winged sides," in one of which farm machinery and implements are kept. The dwelling house and the outbuildings are in most cases built of lumber brought by sea from the lumber-producing region of the northwestern states. The local timber, largely oak, is not suited for structural purposes. Practically all buildings have ordinary gable roofs.

In Cook County the most conspicuous building in the dairy farm group is the silo (Figs. 3 and 4), in which is stored corn ensilage; for convenience it is located close to the cow barn. The cow barn is smaller than that on a dairy farm in San Luis Obispo County and has two stories, the upper one being used for hay and the lower for cattle. It has a gable roof or in some cases a gambrel roof (Fig. 4). The milk house is somewhat smaller than that on a dairy farm on the coast district of San Luis Obispo County. Since milk is sold as whole milk, there is no need for a separator. Some dwelling houses and barns in Cook County are made of vitrified hollow tile from a local factory.

The Dairy Products

The mongrel stock kept on the dairy farms on the coast district of San Luis Obispo County produce a smaller quantity of milk per animal (something over 4000 pounds a year) than improved dairy breeds, and the milk is lower in percentage of butter fat. Cream is separated on the dairy farms and hauled to a creamery where butter is manufactured. The butter market is in Los Angeles, some two hundred miles south, to which the product is transported by truck and by train. During the rainy season, when pasturage is abundant and luxuriant, the quantity of milk produced reaches a maximum; and some whole milk is then sold, from which cheese is made. Towards the middle and end of the dry season the output of butter from the local creamery is small. The restricted supply of cream then comes largely either from those dairy farms on which some land is irrigated and where alfalfa is available or from farms where corn ensilage furnishes supplementary feed.

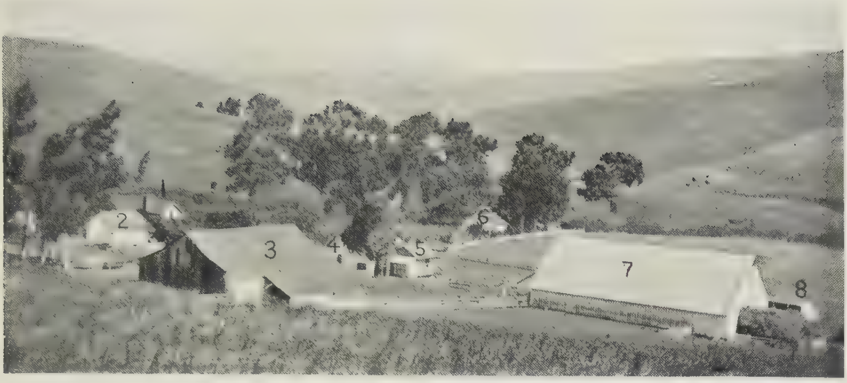

FIG. 2

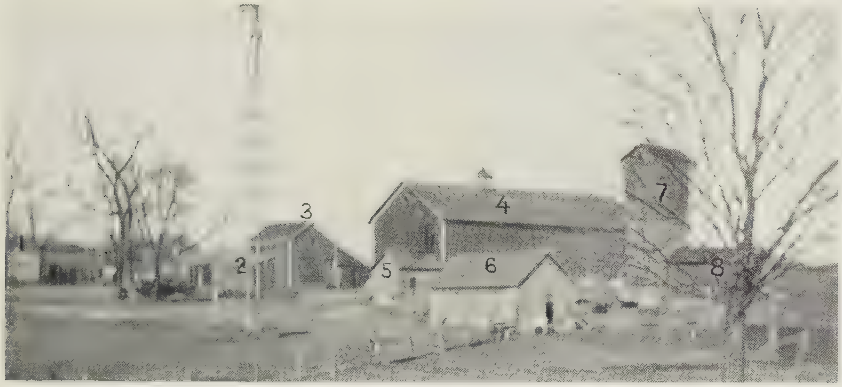

FIG. 3

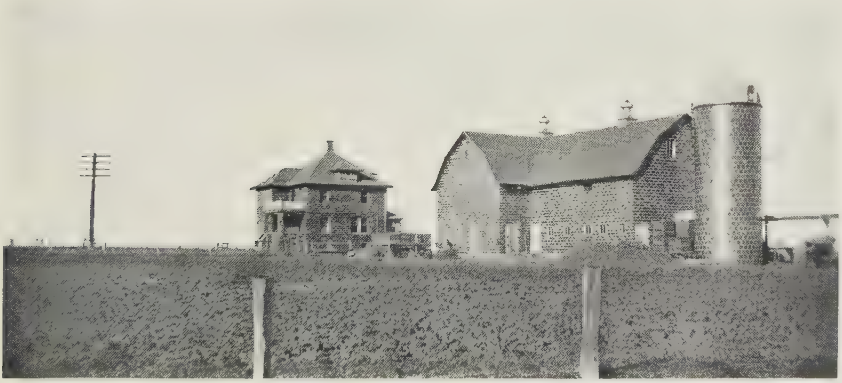

FIG. 4

FIG. 2—A dairy farm in the coast district of San Luis Obispo, Cal.: 1, dwelling house; 2, granary; 3, horse barn; 4, forge and tool house; 5, milk house; 6, mill; 7, cow barn; 8, hogpen (chicken house is not seen).

FIG. 3—A dairy farm in Cook County, Ill.: 1, dwelling house; 2, tool shed; 3, granary, 4, cow barn; 5, milk house; 6, barn for young stock; 7, silo; 8, chicken house and hog pen.

FIG. 4—A dairy farm in Cook County, Ill. The buildings are constructed of vitrified hollow tile.

In Cook County the average annual production of milk per cow is estimated at between 5000 and 6000 pounds. Milk is sold on a whole milk basis, and little attention is paid to butter fat content. The market is in Chicago, only a short distance away, to which 32 per cent of the daily milk supply is taken on trucks.[2]

Labor and Other Problems

A special labor problem confronts dairymen in both districts; in one case it is attributed largely to the isolation of the district, and in the other it is due to the proximity of a large city where wages are higher than dairymen can afford to pay. In the coast district of San Luis Obispo County the dairy farms are twenty to forty miles from "town" and are separated by the Santa Lucia Mountains from a "through railroad." San Luis Obispo is the railway shipping point for the dairy produce of this district. In Cook County the dairy farms are so near to a large metropolis that a hired laborer soon finds he can better his income by getting work in the city. Dairy farmers try to get laborers from distant rural sections; but, after working a year or two on a dairy farm, a laborer is likely to move to Chicago.

On many farms in the coast district of San Luis Obispo County labor is hired only for the season when work is heavy—at the beginning of the rainy season. In some cases dairymen who operate tractors have fitted them with headlights so that plowing may be continued after dark. Work days are 14 to 16 hours long at this season.

On dairy farms in Cook County, cows freshen at intervals throughout the year. Work is distributed during the entire twelve months, but is more onerous during the harvest season. The milk supply must be maintained, for consumption in the city is steady throughout the year. On some dairy farms all the work is done by the farmer and his family. Where hired labor is necessary, it is retained permanently.

The most serious problems confronting dairymen in the coast district of San Luis Obispo County are the improvement of the breed of stock and the provision of supplementary feed in adequate amount. The chief problem at present engaging the attention of dairy farmers in Cook County is that of freeing their herds from tuberculosis, which is associated with indoor conditions. The future prosperity of the industry here will be dependent upon the maintenance of healthy herds.

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[2] M. M. Quaife: "Chicago Highways, Old and New" (Chicago, 1923), reviewed in the *Geogr. Rev.*, Vol. 16, 1926, p. 137.

THE MLANJE MOUNTAINS OF NYASALAND

F. Dixey

Government Geologist, Nyasaland

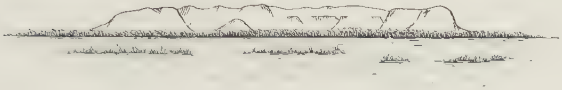

FIG. 1—The Mlanje Mountains as seen from Lake Chilwa.

THE traveler visiting Nyasaland by rail obtains his first good view of the Mlanje Mountains in clear weather from near Chiromo, from which they are seen to rise above the head of the broad, shallow Ruo Valley at a distance of about 45 miles (Fig. 2). Subsequently, near Luchenza, the railway passes within 15 miles of the mountains and affords probably the best point for a comprehensive view. The mountains rise up boldly from the southeastern corner of the Shire Highlands, where they constitute a more or less rectangular mass about twelve miles across, of which the four sides face the four cardinal points. The Shire Highlands lie at an altitude of about 2100 feet. The fine precipices that limit the mountains on almost all sides attain to heights of about 6000 feet, where they form the outer edges of a number of small plateaus that rest upon the flanks of the mass. Behind the plateaus rise numerous high peaks and ridges; while most of these reach altitudes of 8000 to 9000 feet, the highest peak, known as Mlanje Peak, is nearly 10,000 feet in height.

The mountains rise so steeply above the surrounding country that climatic differences are sharply marked. On the Shire Highlands the year is divided into a rainy period extending from the end of November to the end of March and a dry period occupying the remainder of the year, with a cool period following the rains. On the mountains the rains are much more prolonged and are apt to extend intermittently all through the year. On the Shire Highlands the annual rainfall usually ranges from 40 to 50 inches; about the southwestern foot of the mountains approaches 70 inches; on Lichenya Plateau, 4000 feet above, is about 110 inches. The heavy rainfall is an economic asset to Nyasaland in that it has given rise to a valuable tea-growing industry. Moreover the abundant waters of the Ruo and its tributaries, to which it gives birth, not only enable the Shire below Chiromo to function as a river in dry periods but also form potential sources of water power of considerable magnitude. During the cool season frosts and hail are frequently experienced, and ice forms on open pools to a thickness of fully half an inch; moreover, heavy falls of snow occur at wide intervals, as in 1926 for example. In the hot season, during the few months preceding the rains, the cool climate of the mountains affords welcome relief from the heat of the surrounding country.

SOILS AND FORESTS

The soils of the mountains are generally poor, largely because of heavy rainfall and rapid erosion. The rolling grassy uplands that constitute the plateaus are underlain by a black soil only a few inches in thickness, and this rests upon bauxitic clay and weathered rock to depths of 20 to 40 feet. In the intervening densely-wooded ravines and gullies, however, a much greater thickness of soil has accumulated. The grasslands afford grazing for cattle from August to December, and consequently, since grazing becomes more and more difficult on the plains below as the dry season advances, cattle are then not infrequently driven up onto the mountains for pasture. Amidst the grass grow certain small plants with thick gray leaves and yellow flowers which natives used formerly to burn for salt extracted from the ashes.

The steeper mountain slopes above the plateaus usually consist of masses of bare rock, but occasionally they support scattered tufts of grass or a few shrubs; the "drawf cypress," possibly a degenerate form of the Mlanje cypress, also occurs on these slopes. In sheltered places on the upper levels, even within a few hundred feet of the main peaks, a number of bogs persist throughout the year.

On the backs of the ridges, as well as in the cols and on the peaks, the rock is deeply fissured along the joints and in many places is split into innumerable large rectangular blocks, usually rounded at angles and edges: the fissures separating these blocks may be as much as 30 feet deep and 10 feet wide at the top, and they are usually choked with dense scrub. It is this condition that makes the ascent of Mlanje Peak so difficult and exploration of the higher altitudes so strenuous.

The small forests of Mlanje constitute almost the only remaining tracts of really heavy timber forest in Nyasaland. For the most part they consist of patches of Mlanje cypress (*Widdringtonia whytei*) in the valleys and ravines on the higher slopes and plateaus at elevations of 4000 to 7000 feet. The Mlanje cypress is not found in any other part of Nyasaland, and the only other region in which it is known to exist naturally is Chirinda Mountain in the Melsetter district of Southern Rhodesia, where a few small patches of the tree lie at altitudes of 5000 to 7000 feet. At Mlanje the tree frequently attains splendid dimensions, and, in pockets of good deep soil, trees with clean stems up to about 50 feet and measuring 4 to 5 feet in diameter at breast height are occasionally seen. The wood is of a pale reddish color, very durable, and easily worked; it is of great importance locally because it resists the attacks of white ants (termites). *Podocarpus milanjiana*, a tree belonging to the yew family and said to be identical with the "yellowwood" of South Africa, is found sparsely scattered throughout the cypress and other woods of the mountains; it occurs also at the higher elevations in Kenya Colony and Uganda. The trees are of small dimensions, however, and rarely exceed a foot in diameter at breast height. Tree ferns are also of common occurrence on the mountains.

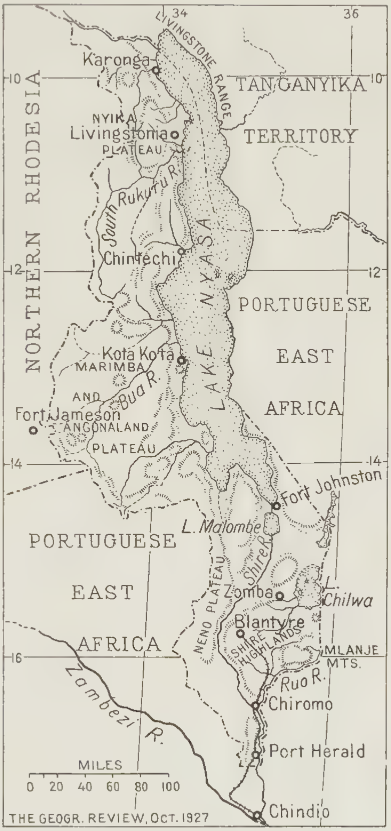

FIG. 2—Sketch map of Nyasaland showing the situation of the Mlanje Mountains. Scale 1: 8,500,000.

There is ample evidence to show that the area of forest land was once much greater than it is at present. For example, stumps of trees may often be seen in the grasslands far removed from any existing forest; since many of these stumps are in a much-burned condition, there is reason to believe that the reduction of the forest area has been largely brought about by the action of uncontrolled bush fires of the past. But in recent years every effort has been made to protect the remaining forest from fire. It is of interest that, although the forest itself is of moist type, the grassland formation that has largely replaced it is of xerophytic type; this is doubtless due to greatly increased exposure to sun and wind which has followed upon the removal of the forest covering from the soil and the loss of the organic matter contained in it. Wherever the soil has been disturbed by the wear and tear of footpaths and the furrowing of wild pigs, or unduly exposed in consequence of frequent grass fires, it is subject to rapid erosion leading to the formation of deep gullies, and such soils as persist on the steeper slopes are generally coarse and gravelly.[1] Accordingly, the difficulties of reforestation tend to increase as time goes on.

There is usually but little game to be seen on the mountains; klipspringer and bush buck are present in small numbers, wild pigs

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[1] F. Dixey, J. B. Clements, A. J. W. Hornby: The Destruction of Vegetation and Its Relation to Climate, Water Supply, and Soil Fertility, *Nyasaland Protectorate Dept. Agric. Bull. No. 1 of 1924*, Zomba.

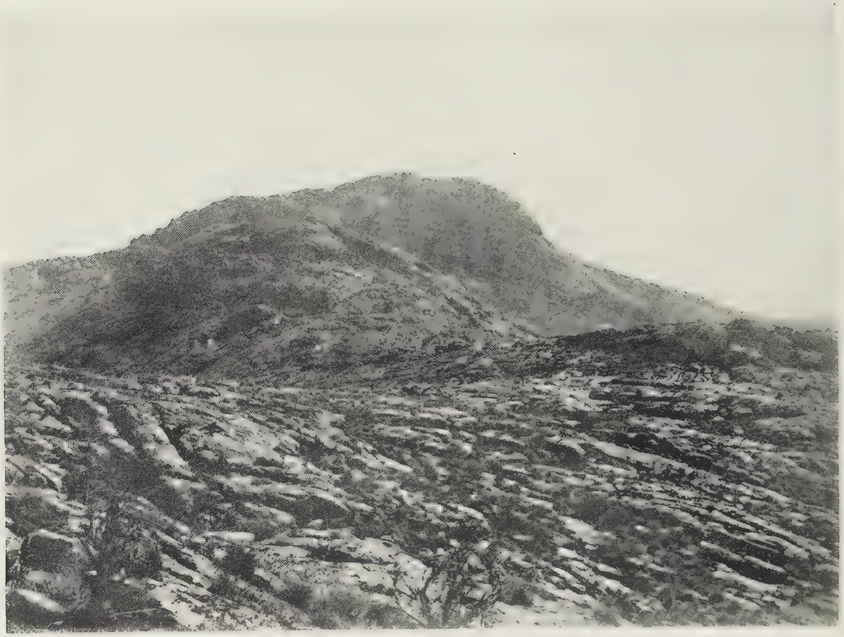

FIG. 3

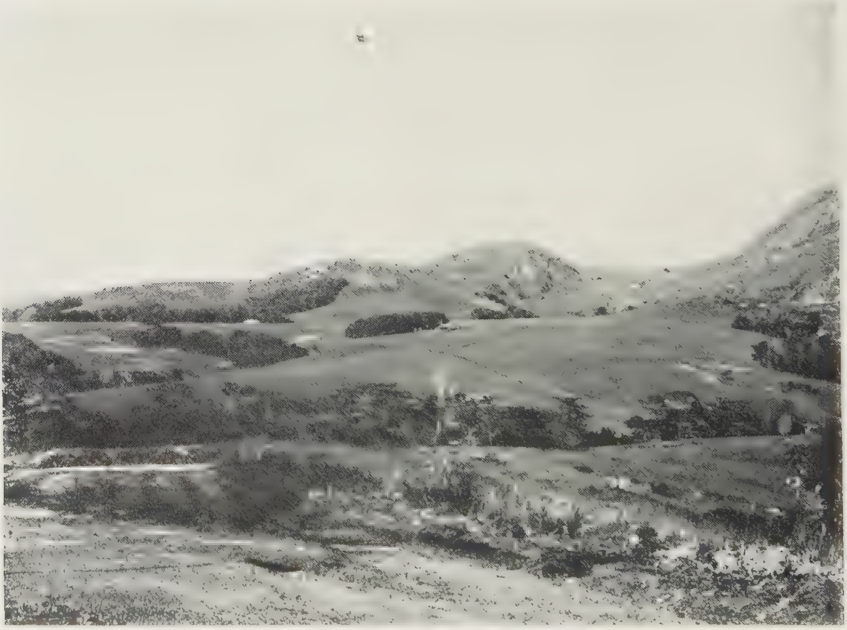

FIG. 4

FIG. 3—Mlanje Peak from the south at an altitude of 9000 feet. Note the sparse vegetation and the rocky nature of the country.

FIG. 4—The northern end of Lichenya Plateau, showing smooth grassland with patches of cypress. The surface is underlain by an extensive deposit of bauxite.

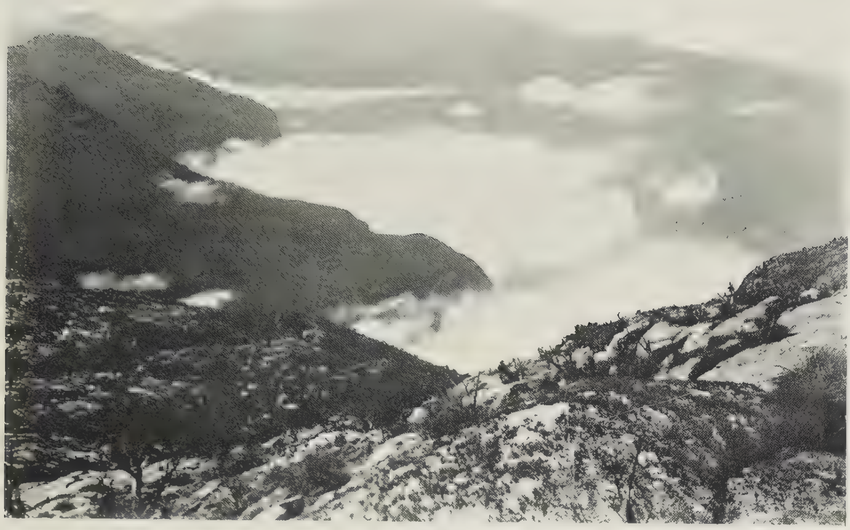

FIG. 5

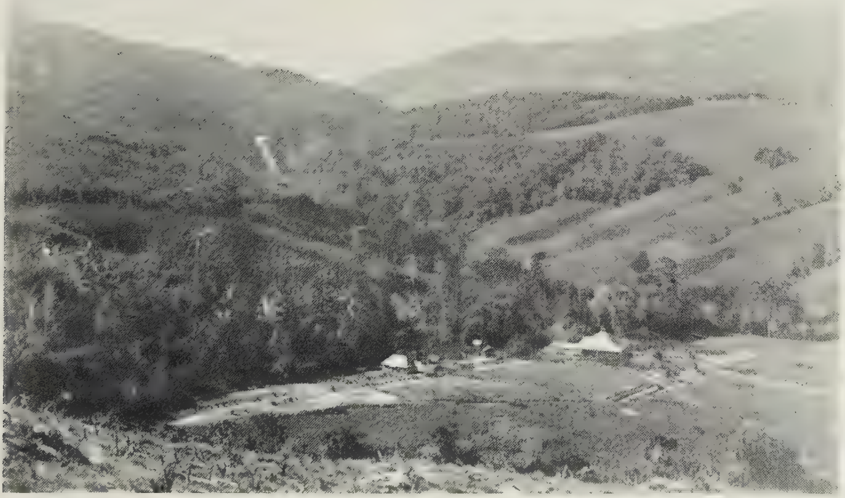

FIG. 6

FIG. 5—The southern scarp of the Mlanje Mountains with the gorges of the Lujiri, Ruo, and Little Ruo. Manene Peak in the distance.

FIG. 6—Lichenya Gorge and part of the plateau with the Forester's cottage in the foreground. The gorge is lined with cypress. In the distance a fine waterfall.

are numerous and very destructive, and leopards are fairly common; during the dry season lions sometimes appear on the plateaus, whither they have been driven by the bush and grass fires of the low country around the foot of the mountains. The bird life is of special interest because, on account of the greater elevation and the colder climate, it shows important differences from that of the Shire Highlands but resembles that of other elevated masses like Zomba Plateau and Chiradzulu.

Apart from the small staff maintained by the Forestry Department and the European visitors of the hot season, the Mlanje Mountains are uninhabited. This is due to the severity of the climatic conditions. When natives accompany Europeans who have occasion to spend some weeks on the mountains during the cold season, special precautions have to be taken to provide them with food, clothing, and shelter, since they are otherwise apt to die from exposure. Local natives state that formerly certain light-skinned people dwelt in the mountains, and Sir Harry Johnston, in his "British Central Africa," refers to native statements as to the recent existence there of "a dwarf race of light yellow complexion" with the physical characters of the Bushman-Hottentot.[2]

The Mountains are accessible only by means of several steep footpaths that follow the less difficult ascents, and, although a track runs from Lichenya to Tuchila Plateau, communication between one part of the mountains and another can usually be made only by walking or climbing over the open country.

The Bauxite Deposits

The Mlanje Mountains have recently attracted attention because of the discovery there of large resources of bauxite, the principal source of aluminium. The occurrence was first recognized by the Geological Survey in September, 1924,[3] and subsequent investigation has shown the deposits to be of great potential value.

The bauxite occurs in the form of superficial deposits on the little plateaus disposed around the flanks of the massif. The principal deposit rests on Lichenya Plateau, although others exist sufficiently near to be worked in conjunction with the main deposit. The Lichenya deposit extends over an area of not less than two square miles; over much of this area it ranges from 15 to 30 feet in depth, and in several places depths exceeding 40 feet have been proved. If an average depth of only 7 feet of workable ore be assumed, the deposit contains not less than 20,000,000 tons of bauxite.

As exposed at the surface of the ground the ore forms hard, platy, porous masses that vary in color from buff to brick red. At a depth of one or two feet it becomes fairly soft, so that it could be excavated easily and at small cost. In composition it is comparable with the red varieties of French and Dalmatian bauxite. Investigations made at the Imperial Institute[4] show that the deposit contains ore suitable for the production of aluminium, aluminous cements, and refractories.

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[2] Sir H. H. Johnston: British Central Africa, London, 1897, p. 53.

[3] F. Dixey: Bauxite Deposits in Nyasaland, *Mining Mag.*, Vol. 33, 1925, pp. 201-205. London.

As regards exploitation it should be noted that the deposits stand on the western side of the Mlanje Mountains at an altitude of 6000 to 6400 feet above sea level, and they are cut off from the plain at the foot of the mountains by a precipitous scarp nearly 4000 feet in height. The foot of the mountains is about 15 miles by road from the Shire Highlands Railway at Luchenza Station, which is nearly 330 miles from the port of Beira. A road for vehicular traffic from Lichenya Plateau down to the plain could only be constructed at excessive cost, and consequently some form of aerial cable transport would appear to offer the best means of communication.

The deposits could be worked without difficulty by means of open cuttings; and, owing to the low gradients available, transport from one part of the plateau to another could easily be effected.

Since ample water or other power is needed it is fortunate that great water power resources exist in the immediate vicinity of the Lichenya deposit. The Lichenya River and its tributaries rise on or near the plateau, and within a few miles they fall through a vertical height of more than 3000 feet; moreover, along the inner margin of the plateau falls of several hundred feet may easily be obtained, and even where the volumes of water considered are small, the available head is very great. Finally, the configuration of many of the upland valleys is such that storage or service reservoirs could be constructed at reasonable cost if found necessary; the more important streams are perennial, however; and, as has already been pointed out, the rainfall on the mountains is heavy.

Labor would have to be imported from other districts, and special provision would be necessary in order to protect the natives during the cold wet weather. From the European point of view, however, the climate is quite a healthful one.

The only important deposits of bauxite hitherto recorded from Africa are those of the Gold Coast, which have been discovered by the Geological Survey within recent years.[5] In view of the fact that the market for aluminium goods in East and South Africa in addition to the other parts of the continent is one of great and increasing importance, it is therefore of interest that the deposit at Mlanje is the only one known on the eastern side of Africa that offers any possibility of commercial development.

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[4] *Bull. Imp. Inst.*, Vol. 24, 1926, pp. 731–736.

[5] A. E. Kitson: Outline of the Mineral and Water-Power Resources of the Gold Coast, British West Africa, with Hints on Prospecting, *Gold Coast Geol. Survey, Bull. No. 1*, 1924. The deposits are large and occur chiefly on the summits of the highest flat-topped mountains.

LAND FORMS OF THE MLANJE MOUNTAINS

The Mlanje Mountains consist essentially of a large syenitic intrusion[6] or intrusions, the erosion of which in the course of ages has given rise to the mountains as we see them today. In spite of the descriptions of early travelers and the beliefs locally entertained, no evidence of former volcanic activity has yet been observed upon the mountains. As yet no evidence of former glaciation has been observed on Mlanje in spite of the elevation. Kenya, on the equator, exhibits traces of glaciation at 10,000, and Kilimanjaro, 3° S., at 11,800 feet; and Mlanje lies 16° S. Probably this is due to the relatively small size of the mass. The present land forms are due to normal erosion.

THE PLATEAUS

There occur upon the mountains a number of relatively small platforms, generally known as plateaus, that may take the form either of wide benches on the flanks of the massif or of broad depressions that form parts of ancient valleys of great size. They lie at elevations of 6000 to 6800 feet above sea level, or nearly 4000 feet above the base of the mountains, and in general constitute rolling grassy uplands intersected by deep wooded ravines and gullies.

The best known example of these platforms is Lichenya Plateau, which attains a total length of several miles and forms the head of a broad shallow valley much dissected by a number of tributary streams; it is half encircled by a wide plateau of slightly higher elevation that terminates abruptly on its outer side in a line of bold precipices. About half a dozen European cottages, occupied in the hot season, lie scattered over the grassy downs of the plateau.

The Tuchila Plateau is a much dissected sloping bench on the northern side of the massif; it is several miles in length, about a mile in width, and made up principally of a succession of long parallel spurs running out from the mountain side. These spurs are separated by deep, densely-wooded ravines and at their outer ends are terminated by bold precipices hundreds of feet in height; the backs of these spurs, of which that surmounted by the Forester's Cottage may be regarded as typical, are broad, gently convex, and overlain by thick turf. The Ruo Plateau, which stands at the head of the Little Ruo Valley, is so difficult of access that it is but rarely visited; to some extent it resembles Lichenya Plateau in general form, but it is of smaller size.

In addition to these plateaus may be mentioned that of the Ruo Valley, which is situated between the Little Ruo Plateau and the Tuchila Plateaus; at the upper end it is uneven, bleak, and rocky, but

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[6] An orthoclase-hornblende-syenite: with the exception of a varying content of quartz, causing the mass sometimes to approach a potash-granite in composition, the rock maintains a fairly uniform character over the whole of the area described.

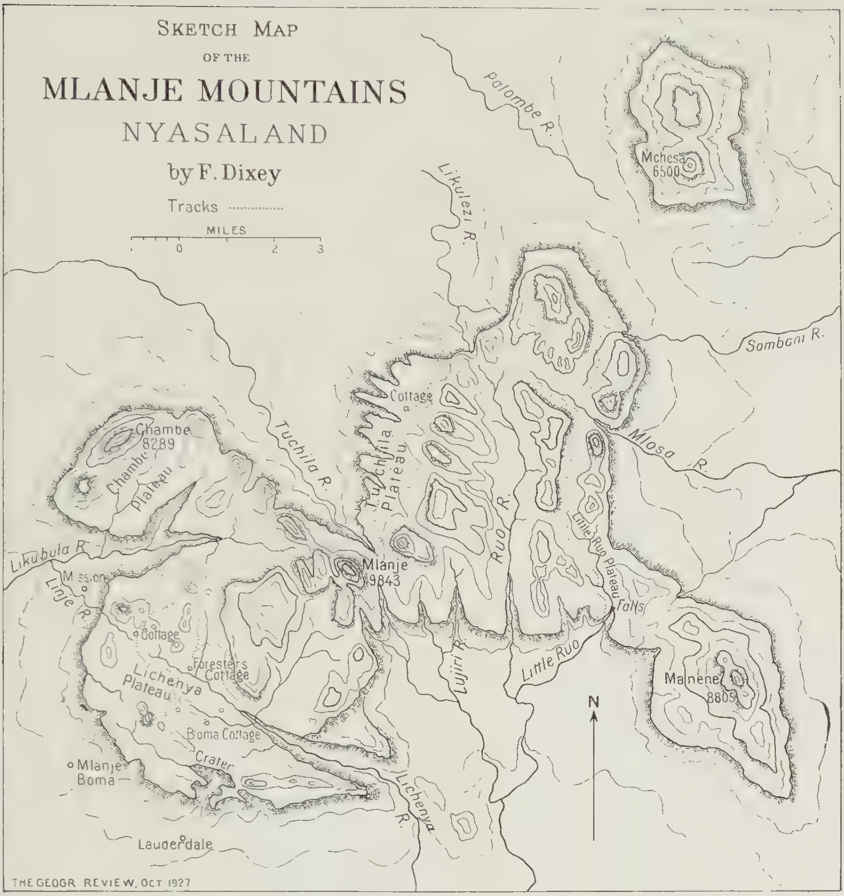

FIG. 7—Sketch map of the Mlanje Mountains. For position see Figure 2.

at the lower end, near the magnificent gorge by which the Ruo descends to the plains, it consists of numerous sharply-divided ridges and spurs similar to those of Tuchila Plateau. North of the Little Ruo Plateau and separated from it by a wide gap is another valley with a broad uneven floor upon which the Mlosa River rises; extending northwards from it and continuous at the farther end with a wide elevated shelf that overlooks the Fort Lister Gap is the Sombani Valley, the floor of which is occupied by several broad grassy ridges. A well-defined plateau extends also from the foot of Chambe Peak around the head of the Likubula Valley, while another small platform runs along the flanks of Manene Peak.

THE VALLEYS

Practically all the upland valleys are abruptly truncated upon reaching the sides of the massif, where they overhang bold precipices that may be as much as 3000 feet in height; moreover, some of the larger valleys, such as the Ruo Valley for example, are truncated at their upper ends also. As may be expected, the larger rivers incise magnificent gorges into their valley floors as they approach the precipices; such gorges, although frequently very narrow, sometimes attain to depths of many hundreds of feet, and the rivers, now actively engaged in extending the gorges headwards, plunge into the depths in one or two splendid leaps. While well-developed tributary gorges also exist, many of the smaller streams have not yet succeeded in cutting notches of appreciable size into the crests of the various precipices; such streams accordingly disappear into the depths at one bound and thus constitute the fine waterfalls that are so conspicuous a feature of the scenery of Mlanje towards the end of the rainy season. In some cases the larger gorges, while maintaining their narrow cleft-like form at their upper ends, open out considerably where they abut on to the precipitous mountain sides.

At least one of the larger valleys that is widely opened at the lower end, namely the Likubula, does not abut directly onto the mountain side but rather onto a well-defined shelf that swings around the flanks of the massif. It is into this widely opened floor and the shelf beyond that the modern Likubula River has incised its lower gorge. The shelf is only about 1600 feet above the modern plain that extends around the foot of the mountains and is thus of much later date than that forming Tuchila Plateau.

A well-defined valley-in-valley form characterizes the upland valleys. The larger valleys that contain the various "plateaus" described above show signs of a former mature or late-mature development; their broad floors are often more than a mile across, and their sides exceed a thousand feet in height. In any typical case the old floor of the valley has been carved into a series of wide steps or rock terraces that fall successively down to the level of the river; in many cases also there extends upwards along the bottom of the valley from the edge of the precipice a deep, narrow gorge. Such features are beautifully developed within the Mlosa and Ruo Valleys for example.

The valley-in-valley structure of Lichenya Plateau has been controlled to some extent by the varying hardness of the enclosing rocks, which consist in the upper part of 60 to 70 feet of relatively soft detritus and the decomposition products of the underlying formation, while in the lower part they consist of hard unaltered syenite. A late rejuvenation has enabled the streams easily and quickly to cut down their beds to these resistant rocks, but the gorges incised into them lower downstream are taking a relatively long time to work upstream to the plateau area. To this slow retrogression is due the preservation of the grassy downs that form such a pleasant attribute of the little plateau.

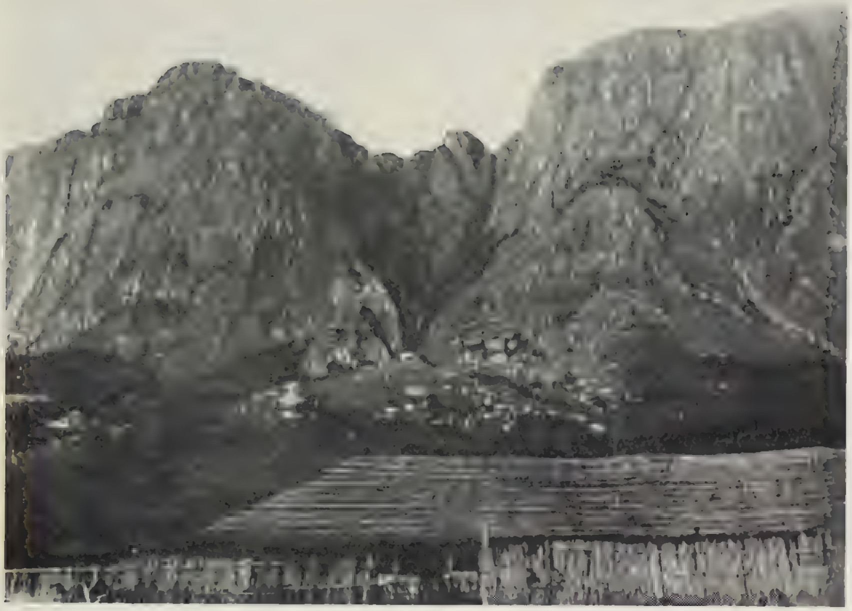

Fig. 8

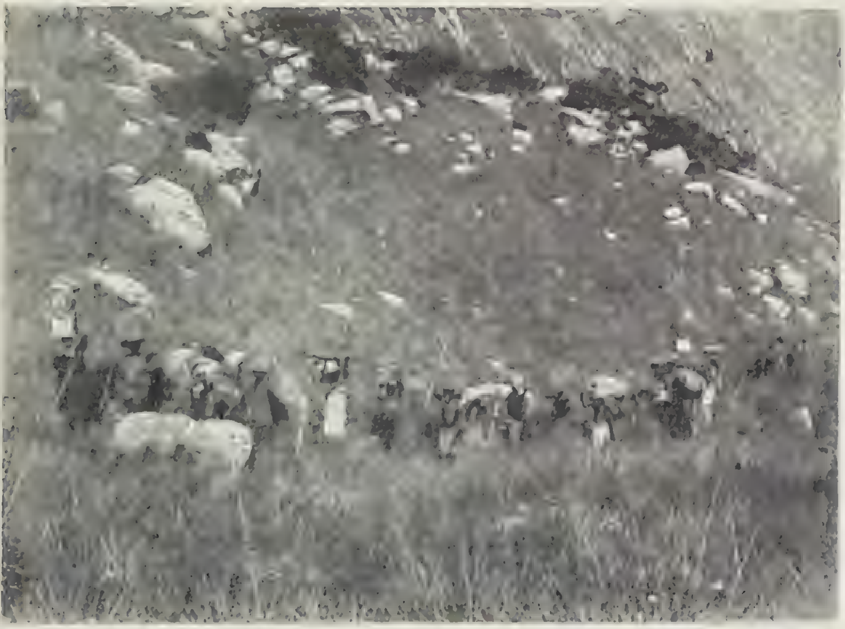

Fig. 9

Fig. 8—The "Crater," an erosional form of the Mlanje Mountains, and part of the western scarp.
Fig. 9—Transportation presents difficulties in the Mlanje Mountains.

THE PRECIPITOUS MOUNTAIN SIDES

The Mlanje Mountains are limited on all sides by bold precipitous scarps or steep rocky slopes which rise abruptly to a height of several thousand feet above the surrounding plain. Erosion is proceeding around the flanks of the massif at a very considerable rate, and it is greatly assisted by exfoliation and by the systems of vertical joints in the rocks. Headward erosion along joints or other lines of weakness running at right angles to the scarps has given rise to deep narrow clefts that run far back into the mountain sides. When a cleft of this type meets another line of weakness running transversely to it, that is to say more or less parallel with the face of the scarp, there arises a tendency to development of a deep caldron-like hollow. An excellent example is that behind Lauderdale Estate known as the "Crater." The view presented upon looking down into the Crater is very impressive. The walls rise vertically to a height of more than 3000 feet: the floor supports a dense forest vegetation that is watered by the spray of numerous streams which finally escape to the outer world by way of a deep narrow gorge. When headward erosion of this type proceeds along parallel lines, it sometimes gives rise to enormous buttresses that project boldly from the adjacent mass. Good examples may be seen behind Lauderdale Estate in the vicinity of the Crater.

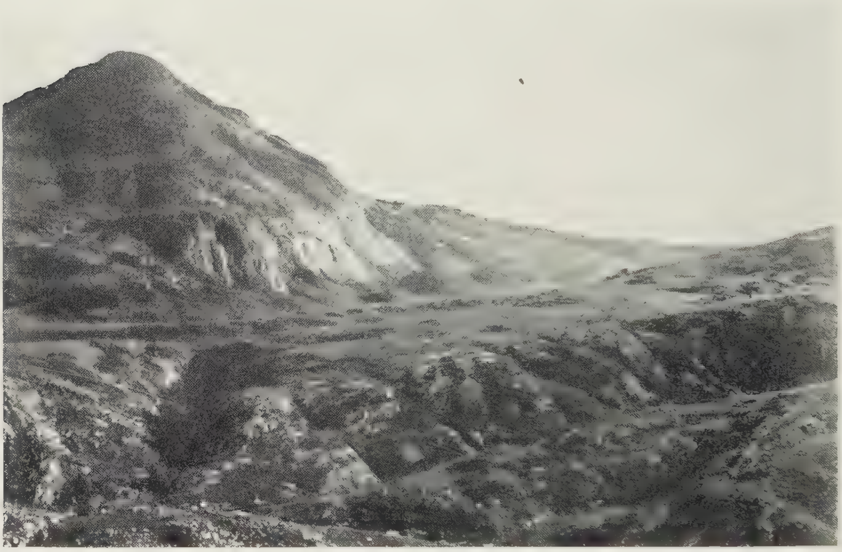

FIG. 10—The Mlosa Valley at the point at which the side is breached and the river captured by a little gorge working up from the main eastern scarp.

An important effect of the rapid retrogression of the main scarps is the diversion of the waters of upland valleys into new channels that run directly down the mountain sides. The modern scarps bear no special relation to the upland valleys; they may run parallel with them or truncate them at any angle. Where a scarp runs parallel with and at no great distance from an upland valley the lateral erosion of the one may so far exceed the downward erosion of the other that the face of the scarp may ultimately encroach upon the side of the valley. If this process continues the outer side of the valley will be lowered more and more until the stream normally flowing down the valley will be diverted to the scarp, whence it will begin to fall down the mountain side and erode a new channel for itself. When this action takes place, the erosion of the old valley floor above the point of capture will be increased, whereas that below will be retarded. These features are well exemplified at the point where the Mlosa suddenly departs from its valley by means of a narrow gorge and then plunges down the eastern flank of the mountains.

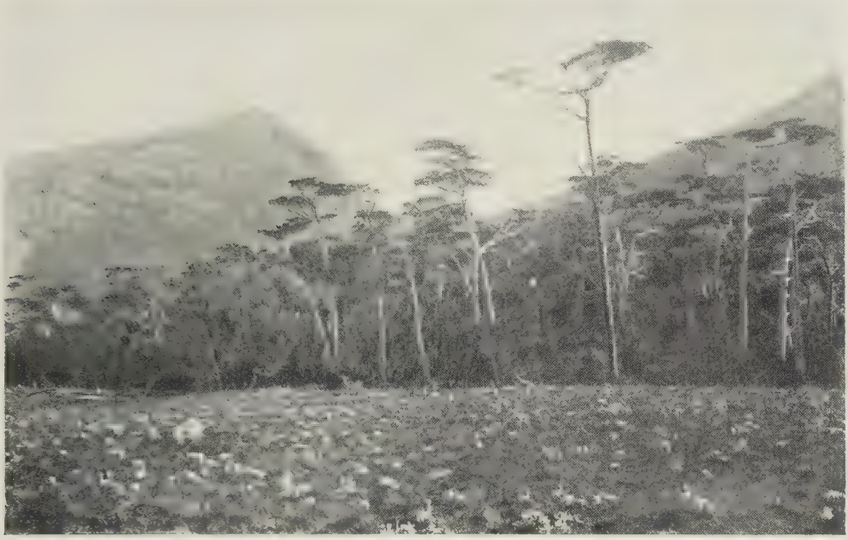

FIG. 11—A patch of cypress showing the usual sharp division between the woodland and the grassland.

PHYSICAL HISTORY OF THE MOUNTAINS

The evolution of the present forms of the Mlanje Mountains has proceeded by four major stages. The evidence for the first stage lies in the pronounced accordance of summit levels that becomes obvious when the mountain mass as a whole is observed from a distance. During this stage the area considered formed but a part of a much larger area, which was ultimately reduced to a region of low relief.

The second stage was introduced by an uplift or series of uplifts amounting to about 3000 feet, as a result of which erosion again became active. The total uplift doubtless occupied a long period of time, but certain benches that can still be traced high up along the valley sides indicate that it was interrupted by one or more periods of quiescence. As this stage advanced the mountains were reduced in area to something less than that of the present day, and they became surrounded by a plain similar to that which, at a much lower level, even now surrounds them. The mountains then rose as broad ridges to a height of about 3000 feet above wide, flat-bottomed valleys and the adjacent extensive plain onto which they opened out. These valleys still remain, at least in part, as the upland valleys of the present mountains, while the outer plain now exists only as the broad shelves that appear at intervals practically around the Mlanje massif.

Towards the end of the second stage considerable deposits of bauxite accumulated upon the broad floors of the intermontane valleys and upon the adjacent plains by the alteration of the underlying syenitic and other rocks. While most of these deposits have been almost entirely swept away as a result of subsequent erosion, some of them, as described earlier in this paper, are still preserved in part.

The second stage was brought to an end by the initiation of a period of intermittent uplift during the earlier pauses of which additional bauxitization took place on the lower levels. To this third stage are ascribed the rock terraces observable on the broad floors of the larger upland valleys. Terraces indicating two distinct pauses can usually be seen, but traces of others can also be distinguished, particularly in the Ruo and Mlosa Valleys. Subsequently to the formation of these terraces a southerly tilting of the area took place. From the manner in which the terrace steps have been carved one within the other, with greatly increased gradients or even cliffs leading successively downwards from the higher to the lower levels, it may be inferred that the sea or other falling base level of the time was situated at a considerable distance, although the tilting observed may indicate that a certain amount of faulting also took place.

To the fourth stage are due the grander and better known features in the relief of the Mlanje Mountains. This stage introduced the great differential movements that raised the upland region of the massif, developed during the preceding three stages, nearly 4000 feet above the surrounding country. It appears more than probable that these movements were due to faulting and, moreover, that they were related to the earlier fractures of the Rift Valley system.

This late faulting of the Mlanje massif took place in two or more main stages that were separated by rather a long pause or pauses, during which the larger rivers had time to open out their lower courses through the mountains into flat-bottomed valleys of considerable width. Subsequent faulting left these valley plains, together with strips of the adjoining lowlands, hanging at an elevation of about

1600 feet above the modern plain. Additional evidence of repeated faulting is afforded by certain low steps running along the flank of the mountain mass, such as those upon which the Mlanje Boma and Mlanje Mission stand, and also by the little Chole Plateau that rises out of the plain a few miles from the western foot of the mountains.

The present magnificent scarps that limit the Mlanje Mountains on nearly all sides and rise as almost vertical precipices several thousand feet above the plain do not, in most cases at least, represent the actual fault faces, since erosion subsequent to the faulting has worn them back in places to distances of fully half a mile. There does not appear to have been additional faulting within Recent times, although earth tremors are of fairly frequent occurrence; but the work of denudation of the mountains is being carried on at a great rate owing to the striking relief of the area, to the frequency with which it has been subjected to rejuvenation, and also to the high rainfall.

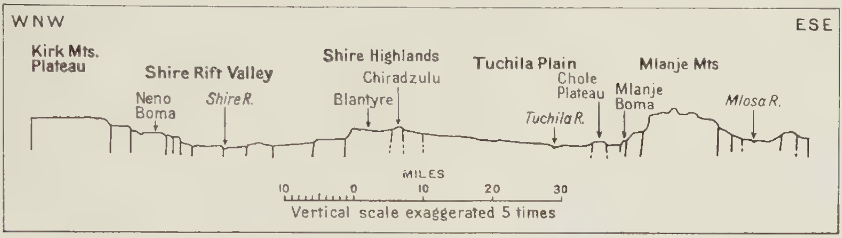

FIG. 12—Section across southern Nyasaland from the Kirk Mountains to the Mlanje Mountains. (After Fig. 2, p. 124, *Geogr. Journ.*, Vol. 68, 1926.)

THE MLANJE MOUNTAINS AND THE GREAT RIFT VALLEY

The broad depression running along the western foot of the Mlanje Mountains may be regarded as a branch of the Great Rift Valley as developed in this part of Africa; and formerly, before its diversion into the Shire Rift as a result of renewed faulting, the drainage from Lake Nyasa escaped by way of this depression and the Lower Ruo Valley. In a northerly direction this branch includes Lake Chilwa and communicates with another that forms the head of the Lujenda Valley.[7]

An east-and-west section across the southern part of Nyasaland and the Mlanje Mountains shows the depression west of the mountains continued by a gradual upward slope that gives rise to the Shire Highlands, beyond which is the deep, step-faulted trough, occupied by the Shire River, that forms the main branch of the Rift in this region (see Fig. 12).

It has already been shown that on the western side of the Mlanje Mountains overlooking this branch of the rift there are several platforms of erosion ranging from a few hundred to 4000 feet in height; these platforms, although doubtless due to faulting in the first instance, belong to pauses that were sufficiently long for complete accordance to develop between them and the valleys with which they communicated. It is regarded as probable that the younger of these platforms are related to those earlier stages in the development of the Rift Valley during which Lake Nyasa stood at 700 to 1000 feet above its present level; an examination of the lacustrine sediments fringing the northwestern shores of the lake shows that these movements date back into pre-Pliocene, probably Oligocene, times and that they have continued intermittently almost down to the present day. The older and higher platforms on the other hand, such as those upon which are developed the bauxite deposits already referred to, are evidently of much greater age; it may therefore be concluded that before the rifting dated by the Nyasan sediments there had been yet earlier faulting of similar intermittent type preceded by a wide general uplift.

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[7] See F. Dixey: The Nyasaland Section of the Great Rift Valley, *Geogr. Journ.*, Vol. 68, 1926, pp. 117–140.

LAPIÉS IN HAWAIIAN BASALTS

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The University of Hawaii

CVIJIĆ[1] has given American geographers an excellent description and explanation of lapiés, a detail of limestone erosion familiar to the geographers and geologists of central Europe. They are also known by the German names "Karren" and "Schratten," and are "surfaces covered by a network of furrows and crests" formed by chemical erosion of the purer sorts of limestone. The channels range in general from 1½ to 3 feet in depth; but some are 6 to 10 feet, and extreme examples may be as much as 30 to 40 feet deep. The ridges, if broad, may be roughened by furrows of a smaller order of magnitude. In uniform rocks the lapiés tend to parallelism; but irregularities are caused by bedding, concretions, fissures, joints, etc. Sloping surfaces are most favorable; but the forms may be developed on vertical, though never on horizontal, surfaces. Vegetation and soil impede their formation.

Lapiés go through a series of characteristic stages, or a cycle, which begins immediately after the laying bare of a limestone surface. In youth the channels are shallow and are separated by low, sharp ridges. In maturity the greatest ruggedness is reached, the sides of the ridges have the steepest possible inclination, and the channels have their maximum depth. In old age the ridges are destroyed by being undercut and break off as blocks of fantastic shapes. The end of the cycle is characterized by heaps of limestone blocks resting on an uneven surface, often covered by residual clays and vegetation. The lapiés may be rejuvenated one or more times until the channels reach the level of permanent ground water.

SMALL-SCALE FORMS

Two types of surfaces that in many respects resemble the lapiés of limestone regions have been developed on the basalts of the Island of Oahu, Territory of Hawaii. These forms are also found on others of the Hawaiian Islands but in only a few instances that I can cite from my own observations. In the one type the feature is developed on a small scale. It consists of a fluting of rock surfaces, the distances between ridge crests being in general from two to six inches. The depth from crest to trough varies from an inch to ten inches. There is little variation of size from top to bottom of any one groove or ridge. Boulders in the upper part of Kalihi valley, back of the western part of the city of Honolulu, show such flutings. The best example, so far as my observations go, is on the southwestern headland of Waimea Bay, on the northeast coast of Oahu. These are illustrated in Figures 1 and 2, in which the pocket knife gives the scale. The rock is basalt of an unusually thick and dense flow. The edge of the flow has been undermined by wave erosion, its massiveness enabling it to resist erosion rather effectively so that it forms a distinct structural bench. The dense texture makes it almost impervious in contrast to most Hawaiian basalts. A permanently wet spot exists on the surface of this flow and, presumably, is the discharge of a small body of perched ground water. The water escapes by trickling down over the edge or through the few vertical joints and has grooved them. The stream has, with rare exceptions, always been so thin that molecular attraction has held it in contact with the rock surface and greatly retarded its rate of fall. As a consequence powers of mechanical erosion have been negligible; but, on the other hand, whatever solvent action there may have been has been continuous and unceasing. Basalts, since they are rich in iron, calcium, and magnesium, are relatively susceptible to chemical attack, and it appears that the perpetually trickling streamlets have been able to dissolve channels. Once a channel had been started along some fortuitous course it would concentrate and direct the movement of the water, resulting in further deepening of the channel. The continual movement of the water, though gentle, would be adequate to the removal not only of the dissolved matter but perhaps

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[1] Jovan Cvijić: The Evolution of Lapiés, A Study in Karst Physiography, *Geogr. Rev.*, Vol. 14, 1924, pp. 26–49.

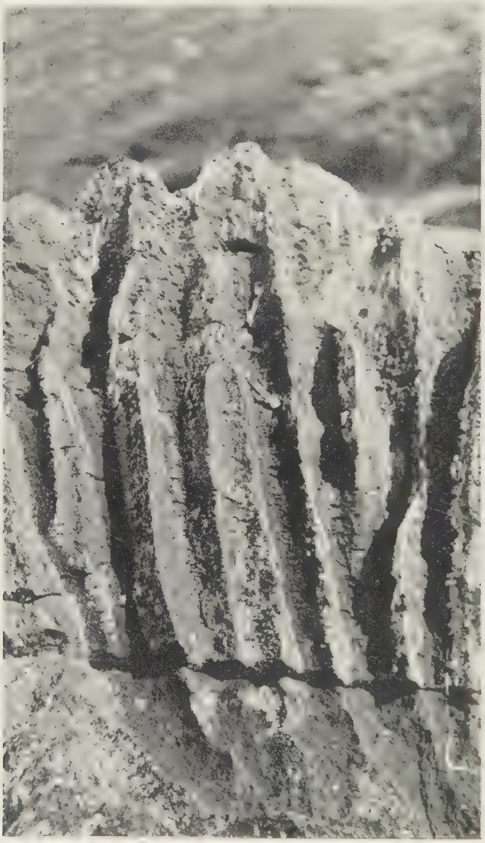

FIG. 1—Lapiés-like flutings on dense olivine basalt, southwestern headland of Waimea Bay, northwest coast of Oahu.

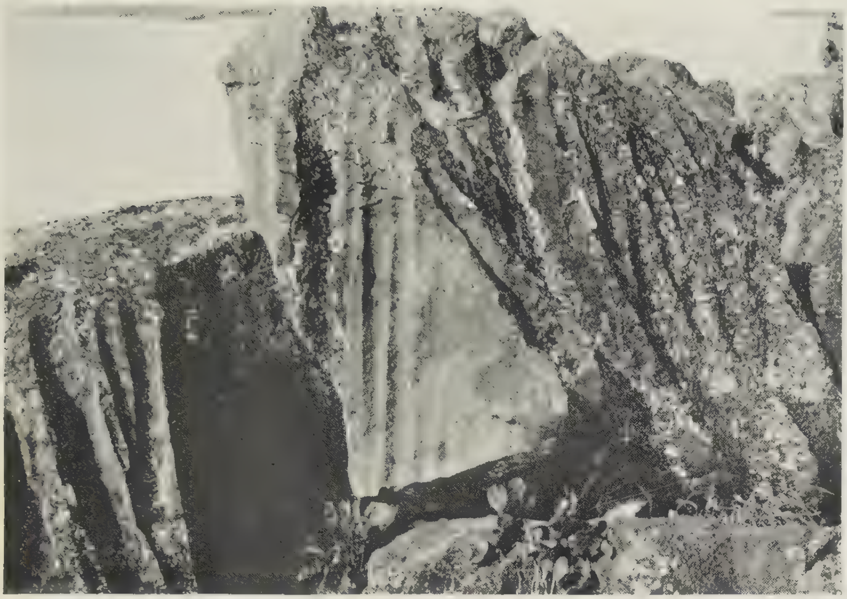

FIG. 2

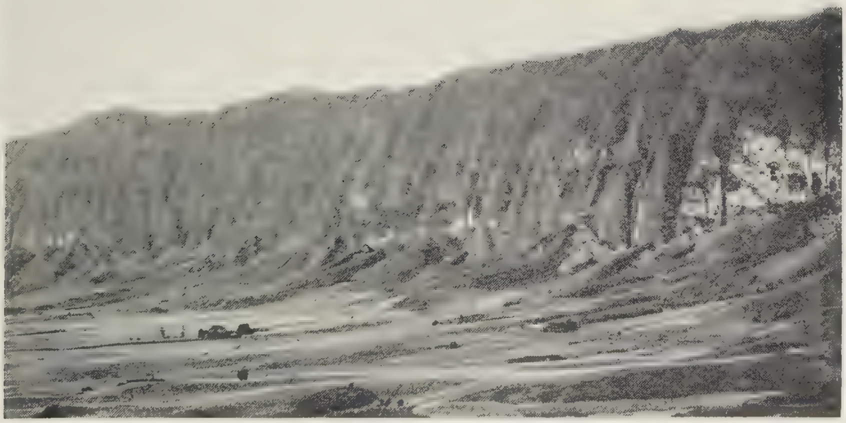

FIG. 3

FIG. 2—Another view of flutings at Waimea Bay.

FIG. 3—Waimanalo cliffs, southeastern end of the northeast shore of Oahu, illustrating the major type of lapiés-like flutings.

also of some of the decomposed mineral grains in a mechanical way. This type is rare.

LARGE-SCALE FORMS

The second or major type of Hawaiian lapiés is on a far grander scale. It is best developed on the cliffs back of Waimanalo at the eastern end of the northeast coast of Oahu. Less striking flutings are found in Lualualei and Makaha valleys on the leeward side of Oahu, in Iao and Waikapu valleys on the Island of Maui, and elsewhere. The flutings at Waimanalo (see Fig. 3) extend vertically 1600 or 1700 feet, that is from the top of the cliffs, 2200 to 2500 feet above sea level, down to the tops of alluvial slopes 600 to 800 feet above sea level. At Waimanalo the ridges in general are spaced 150 to 200 feet apart. It is impossible to make a satisfactory photograph of the detail of these flutings because of the dense undergrowth and the rough terrane. The few that I have examined have walls that are 75° to 85° from the horizontal. They are covered with a remarkably continuous blanket of vegetation, largely grasses, ferns, and vines. At the head of each fluting there are one or more vertical streaks a foot to a yard wide almost devoid of vegetation, down which water trickles most of the time. The unusual aspect of these flutings leads one to apply unusual terms to them. Locally the term "vertical valleys," which is due to Vaughan MacCaughey, is sometimes applied to the grooves, and "washboard topography" to the ensemble.

The drainage area tributary to each of the flutings back of Waimanalo is very small because the divide is close to the top of the cliff. It is of the order of seven acres for each channel. The rainfall is of the order of 100 inches a year, which would give a mean discharge of water of about one-twelfth of a cubic foot per second if there were no loss by evaporation or by absorption. The Waimanalo cliff faces a little east of north, which is favorable for "catching" the orographic rains from the northeast trade wind. The run-off is relatively uniform. The small but persistent run-off from these collecting basins supplies a gentle, steady flow of water, enough to trickle continually down the bare strip at the back of the furrow and slowly to deepen it. Molecular adhesion causes the small stream to adhere to the rock as a thin film. The water cannot break away, it cannot fall freely and develop a high velocity, and it is therefore not a strong agent of mechanical erosion. The work of erosion must be done chiefly by solution, just as in the small-scale flutings first described. So far as my observations go there are no lapiés-like flutings on any intermediate scale.

HYDROGRAPHIC SIMILARITIES IN BASALT AND LIMESTONE

From the preceding discussion it appears that the slightly soluble Hawaiian basalts, under the requisite conditions of steep initial topography and small but continuous flow of water, tend to develop details of erosion which are remarkably similar to the lapiés details of limestone regions and which are similarly due in large part to chemical erosion rather than to mechanical erosion. We may note that the term "erosion" is here modified by the attribute "chemical," instead of the usual "mechanical." "Chemical" usually refers to weathering or decomposition: here, however, "chemical erosion" seems appropriate.

Another analogy between the basalts of Hawaii and the limestones of karst regions may be noted; namely, that in both the ground-water table is remarkably low. This is almost proverbial of limestone regions. The force of this statement with respect to Hawaiian basalts may be seen from the fact that those who work on problems of ground-water geology in Hawaii speak habitually of the *elevation* of the water table above sea level and not of the *depth* of the water table below the ground surface. In Hawaii the water table is normally close to sea level. The basalts are in general extremely pervious to water, as are many limestones. Thus basalt regions, like many limestone regions, are characterized by a scarcity of surface streams. Many miles of the "Government Road" on the slopes of Mauna Loa need no culverts as the water from rains sinks underground promptly instead of collecting to form streams.

NOTES ON THE TORNGAT REGION OF NORTHERN LABRADOR

Robert H. Woodworth
Harvard University

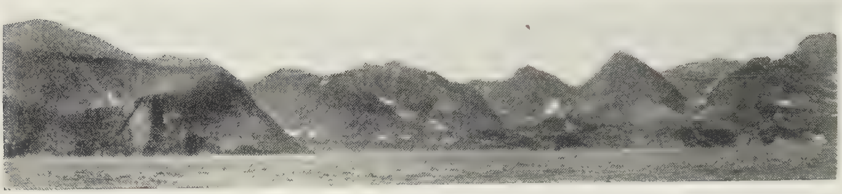

FIG. 1—The Labrador Coast. Looking north in Ryan's Bay.

ANY account of northern Labrador must be prefaced by the statement that it still remains "one of the least known parts of North America."[1] Especially is this true of the mountainous country called the Torngat region. This system emerges from the sea along the last 250 miles of the coast as perpendicular cliffs attaining occasionally 3000 and even 3500 feet, but dwarfed by the heights beyond. The rocks are as old as any exposed on the surface of the earth, being part of the great Canadian shield, but they have been so consistently raised that in terms of the erosion cycle these alpine mountains are still in maturity. The plateau is everywhere dissected by streams which have thus far eroded deep, narrow valleys. The peaks rise to 5000 and 6000 feet, and at least one of these probably reaches 7000 feet, in which case this system would exhibit the highest land anywhere in the eastern part of North America. During the last advance of the ice those valleys under 2500 feet were subjected to glaciation and as a result, running in from the sea and winding away among the hills for from twenty to fifty miles, are some fifty of the grandest fiords of our earth. The vegetation is dwarfed and typically arctic, growing mainly in the valley bottoms, trees being found only in the very southernmost portion of the region: soil is scarce—conditions that make the Torngats perfect for geological study.

The writer visited the region during the summer of 1926 on the expedition planned and commanded by Columbus Iselin 2nd, who had built especially for the trip the 37-ton auxiliary schooner *Chance* and was under the advisorship of Dr. Henry Bigelow of Harvard University. The expedition was mainly concerned with the study of the upper Labrador Current[2] and the fauna and flora of the Torngats.

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[1] Compare A. P. Coleman: Northeastern Part of Labrador, and New Quebec, *Canada Geol. Survey Memoir 124*, Ottawa, 1921. Other admirable reports on parts of this region are Dr. W. T. Grenfell's well known book "Labrador," new and revised edit., New York, 1922; E. B. Delabarre: Report of the Brown-Harvard Expedition to Nachvak, Labrador, in the Year 1900, *Bull. Geogr. Soc. of Philadelphia*, Vol. 3, 1902, pp. 65–212; R. A. Daly: The Geology of the Northeast Coast of Labrador, *Bull. Museum of Comp. Zoöl. at Harvard College*, Vol. 38 (Geol. Ser. Vol. 5), 1902, pp. 203–270.

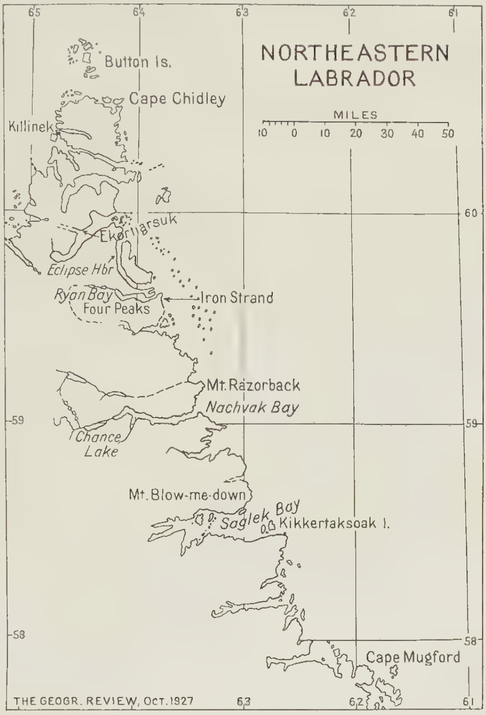

FIG. 2—Map of northeastern Labrador. The northernmost part is based on Bernhard Hantsch's map (1908) accompanying his "Beiträge zur Kenntnis des nordöstlichsten Labradors," *Mitt. Vereins für Erdkunde, Dresden*, Vol. 8, 1909, pp. 168–229, and Vol. 9, 1910, pp. 245–320. The remainder of the coast is based on the map accompanying Coleman's report (see footnote 1). Additions and corrections have been made by the author on the basis of the 1926 expedition. Scale of map approximately 1:4,000,000.

THE SOUTHERN TORNGAT REGION

The region of Cape Mugford marks the southernmost portion of the Torngats. The mountains rise 2000–3500 feet directly from the sea. For the lower 800 feet they are of gray granitic rock; above, all is dark, horizontally stratified rock of sedimentary origin. They present a most striking appearance, the more so after the relatively low land of southern Labrador. Our first work in this region was in Saglek Bay. From Cape Mugford to Saglek Bay bare, snowcapped mountains border the coast. On August 8 we entered this fiord to the south of Kikkertaksoak Island and ran along the southern shore under cliffs rising 1000 feet out of the sea. Cutting these cliffs are many great vertical and horizontal dikes of black intrusive basaltic rock. Above 2000 feet the mountains were covered by patches of snow and ice. Warm blasts of wind swept down from the hills—a chinook effect described by Coleman.[3] Although the temperature on the water is cool, the bare granite rock gets very hot after a day of scorching sun. Just beyond the cliffs at the entrance is a broad S-shaped trough from about 1200 feet down to the water, apparently scooped out and smoothed by a small entering glacier. Several small icebergs were afloat in the bay;

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[2] See the paper by C. O. Iselin: A Study of the Northern Part of the Labrador Current, *Bull. Natl. Research Council No. 61* (= *Trans. Amer. Geophys. Union, 1927*), Washington, 1927, pp. 217–222.

[3] *Op. cit.*, p. 11.

but, as we had pushed through fields of hundreds of huge bergs for 500 miles, they bothered us not at all. A high snow-covered and cloud-mantled range fills the northwest. After sailing in for five miles we saw two Newfoundland fishing vessels anchored in a cove on Kikkertaksoak Island. Myriads of mosquitoes, locally known as "flies," swarmed about. The fishermen reported salmon in the bay; this was interesting because, while they run in the rivers of southern Labrador, heretofore they had not been recorded anywhere near so far north. Later, on leaving the bay, our skipper was presented with a twelve-pound cock salmon. These fishermen are interested only in cod, which they salt down.

The fiord is several miles wide and very deep with walls about 1200 feet high. Many brooks dash out from under snow patches upon the land and cascade down over the cliffs. Twelve miles west the bay branches into two arms each about a mile wide. At this point, beside a stream entering from the north, was an Eskimo encampment of five tents, but seemingly with enough people to fill twice that number, for there were many children. We later learned that the Eskimos were camping on the best trout stream in the bay. They live on trout during the summer, catching the fish in nets. All of them appeared well fed and cheerful. Some thirty miles from the sea navigation ends, and the glacial valley is occupied by a meandering river. Because of the great depth of the fiord it is necessary to anchor on the river delta.

ATTEMPT TO REACH THE TOP OF THE PLATEAU

One of the objectives of the trip was to make collections of the fauna and flora of the unglaciated regions of the Torngats—the country above 2000 feet. The Long Range of Newfoundland and the Shickshock Mountains of Gaspé, which were not touched during the last advance of the ice, are characterized by endemic species of western affiliations mingled with the arctic-alpine forms from the postglacial. The Torngats are known to be similar: as Professor Fernald says, "Our knowledge of the flora of the high mountains of northeastern Labrador is very incomplete. . . . Of course, the more generally dispersed arctic types are there; but the Torngat region at once stands apart from the rest of the Labrador Peninsula on account of the cordilleran species isolated there."[4]

There being no way out of the valley where we were anchored, a party went in to find a place of possible ascent; but no such possibility existed within the first twelve miles, nor was anything promising seen ahead. The débris weathered from the cliffs has formed great cones of rotten rock which sometimes reach one third of the distance to the top of the cliff, and boulders of all sizes are constantly tumbling down from the heights. Tramping over the broken rock fragments was difficult. Caribou tracks were plentiful; ducks were there, and every cliff seemed to have its pair of hawks; arctic trout (Greenland charr) were spawning in the stream. One of our fishermen caught a twelve-pound trout that measured forty inches. An old Eskimo village was seen on a wave-cut terrace twenty-five feet above the present level of the bay. There were several works of stone about two feet by seven feet, with a stone-paved base, walls four feet high, and no roof.

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[4] M. L. Fernald: Persistence of Plants in Unglaciated Areas of Boreal America, *Memoirs Gray Herbarium of Harvard Univ.*, No. 2; *Memoirs Amer. Acad. of Arts and Sci.*, Vol. 15, 1924–26, pp. 237–342; reference on p. 316.

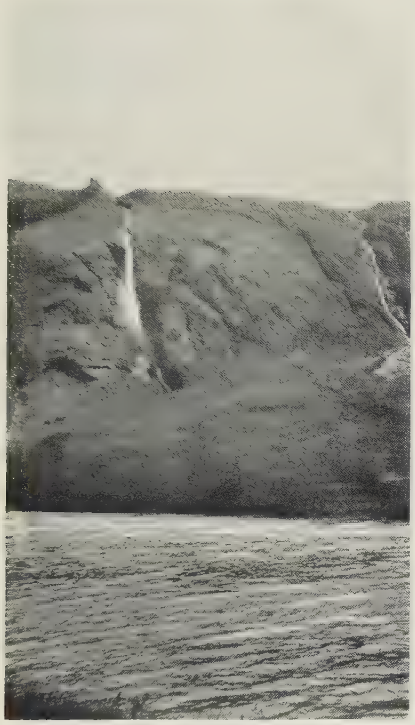
FIG. 3

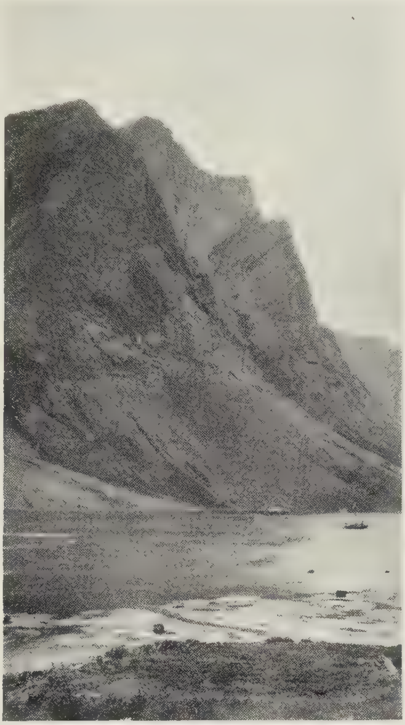
FIG. 4

FIG. 3—Lee Falls (south wall of Nachvak) one mile distant. Nachvak River in foreground.
FIG. 4—Schooner *Chance* anchored on delta at head of northwest arm of Saglek Bay.

Early on August 13 we started north for Nachvak Bay. All night we had been held up by heavy fog. The charts for these waters are crude and inadequate, and icebergs make sailing dangerous by night unless the skies are clear. Leaving Saglek we made our way past the range called Mt. Blow-Me-Down, rising just behind the coast wall to a height of 3500 feet, impressive with its snow-filled valleys and rugged contours. On the cliff walls facing the sea is

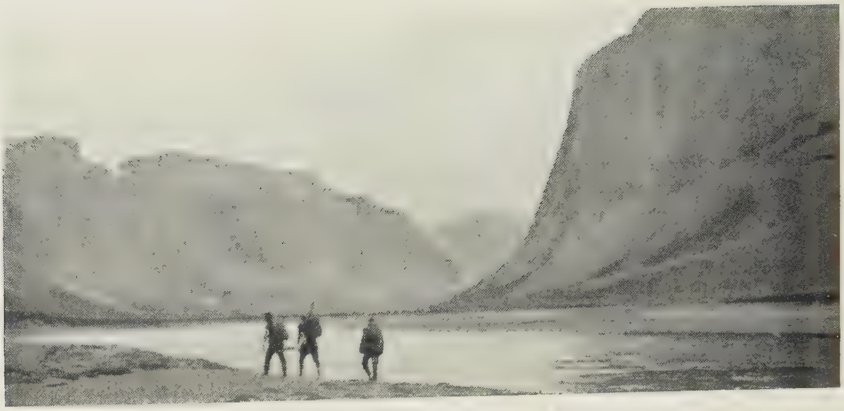

FIG. 5

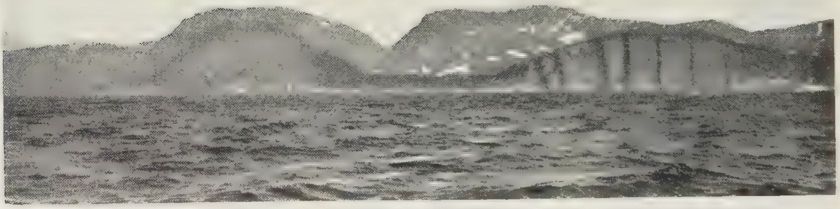

FIG. 6

FIG. 7

FIG. 5—Northwest arm of Saglek Fiord; cliffs 1000 feet, ascent impossible.
FIG. 6—Dikes of basalt. Coast just north of Saglek.
FIG. 7—In Nachvak, looking southwest from anchorage two miles in the fiord, 7 a. m.

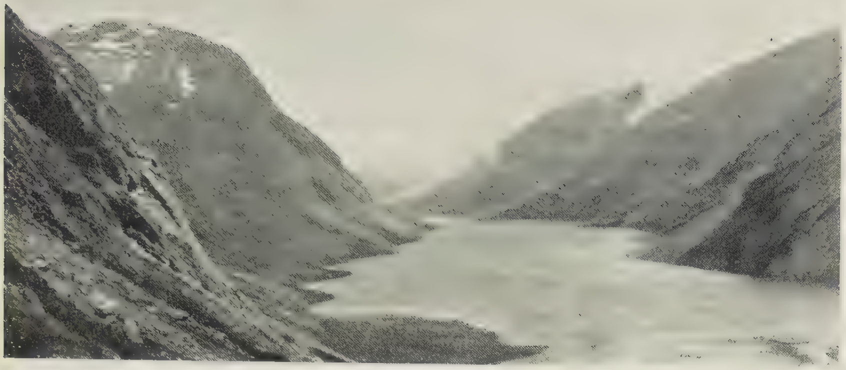

FIG. 8

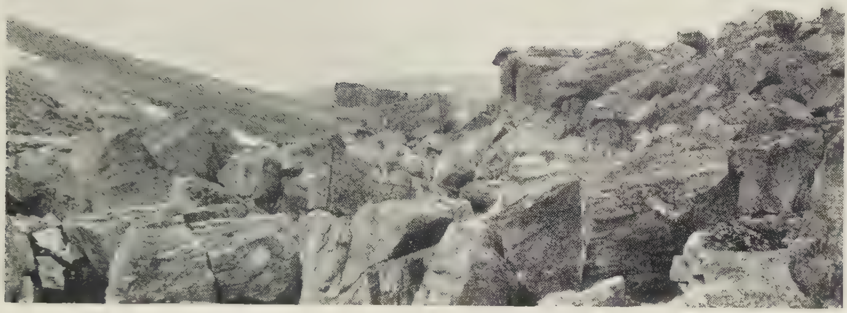

FIG. 9

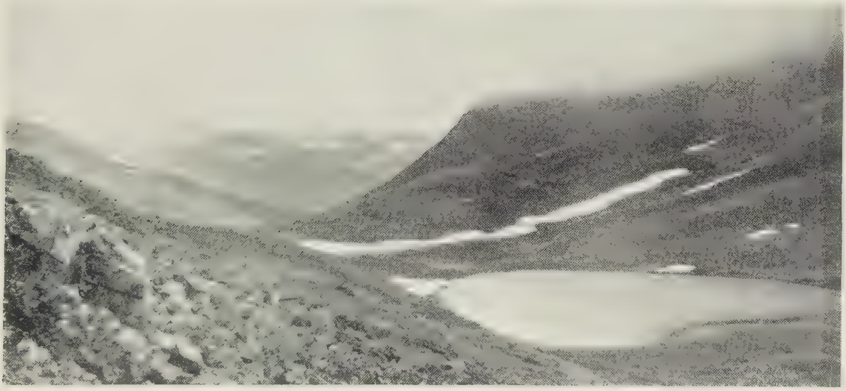

FIG. 10

FIG. 8—Nachvak. Chance Lake looking east.
FIG. 9—Nachvak. Typical Torngat topography; ten miles northwest of Chance Lake (2800 feet).
FIG. 10—Nachvak. Eight miles northwest of Chance Lake at 2500 feet. Fog above.

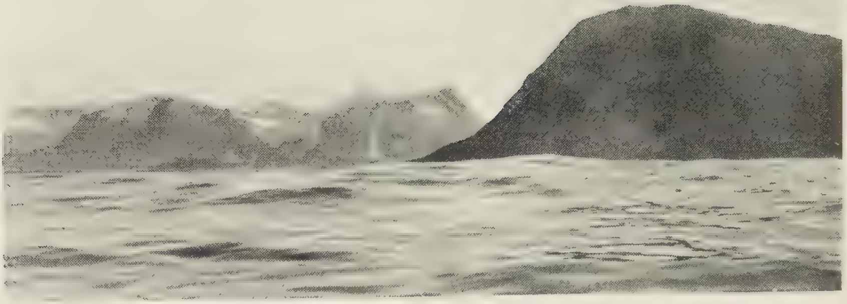

FIG. 11

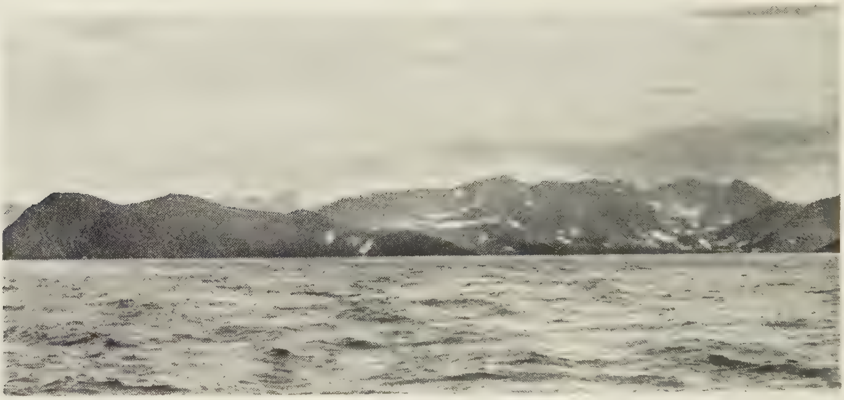

FIG. 12

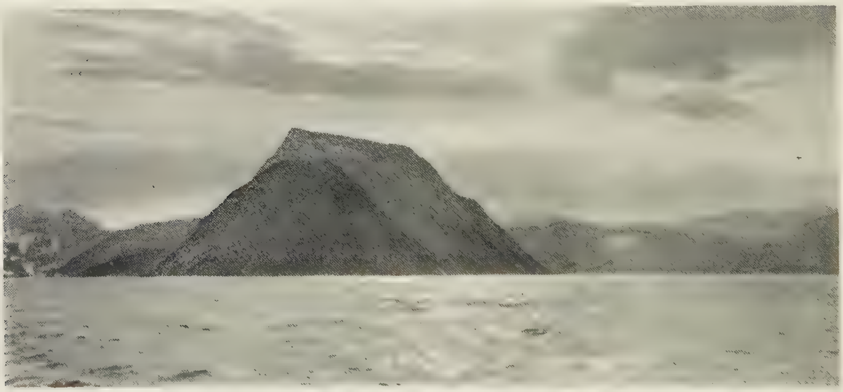

FIG. 13

FIG. 11—"Four Peaks," *c.* 7000 feet, from one mile northeast of region of the Iron Strand.
FIG. 12—Three of "Four Peaks" (left center). Entrance to Ryan's Bay at right.
FIG. 13—Coast just north of Ryan's Bay.

the best display of dikes seen by us in the whole Torngat region. Broad vertical bands of black basalt traverse the granite masses in many places, some of them 100–200 feet wide and one at least 300 feet wide. These dikes run straight back through the hills of Mt. Blow-Me-Down and can be plainly seen for miles as black ridges.

Nachvak Bay

The next day we sailed into beautiful Nachvak Bay, probably the best known of the northernmost fiords on the Labrador coast. At the right of the entrance Mt. Razorback rises 3500 feet out of the water, maintaining its height for four miles as a serrate ridge. Easily noted from sixty miles out at sea, it is a fine landmark for incoming vessels. Nachvak Fiord averages about a mile in width with 1000-foot hill cliffs on either side. Strong gusts of wind draw down through the great trench, and sailing folk must be cautious. Ten miles inland the fiord branches. Thus far the cliffs are not so steep-sided as those of Saglek. Several miles inland the northern arm makes an abrupt turn to the west, and after six miles it again turns to the northwest. About thirty miles from the seacoast a large delta has been built completely across the fiord. Here we anchored.

On the Plateau

It was now decided to make a definite attempt to get out of the fiord valley onto the upland. We carried our gear and a motor skiff about a quarter-mile across the delta to the upper end of the fiord and motored to the end of this body of water, which we called Chance Lake. It is eight miles long and a little less than a mile wide. The cliff walls are here perpendicular, like those of Saglek, and 1000 feet high. Hanging valleys, marking the entrance of smaller glaciers, come in high up on these walls. At the end of Chance Lake we left the skiff and waded up the river for a mile, an easier route than through the tangle of willows and alders. Falls cascade over the cliffs about every half mile. Two miles from the lake the valley floor is filled by a 250-foot flat bank of alluvium, the delta of the river at a time when the land was lower than it now is. As the land has gradually risen, the river has cut its way down through the old delta to the rock floor. At this point, about thirty-five miles west of the coast, we made our way out of the valley over the very steep 900-foot north wall. Upon reaching the top of the cliff we found ourselves surrounded on three sides by mountains 4000–5000 feet high. A supporting party of four men departed to help establish a base camp at 3000 feet for the two men who were to work there for two weeks while the vessel went offshore to take a cross section of the continental shelf.

We worked back to a region some forty-five miles west of the coast at 3000 feet but could see nothing of promise. The permanent snow line was at 3000 feet, so that the unglaciated portions were not producing life—this year at any rate. There was no vegetation except mosses and lichens. We experienced incessant rain, fog, and cold wind. Clouds enveloped everything above 5000 feet. There were innumerable snowdrifts and several cirques, but the glaciers in them did not appear to be active. We had entertained thoughts of working west so that we could at least see Ungava Bay, but this was impossible with the little time available and the rough country encountered. The mountains rose to four, five, and perhaps six thousand feet, none of them named or located on the maps.

The Northern Waters

Returned to the vessel we sailed out one hundred miles offshore to make a cross section of the continental shelf, taking water samples and temperatures at various depths. The strongest part of the Labrador Current is about twenty miles offshore. It runs about two knots and is apparently a surface current, because on our way south in perfectly calm weather we drifted twice as fast as the large and deep icebergs. It is evident from the massive block-like form of the icebergs in northern waters that the smaller and more weathered bergs which get south into the shipping lanes are at least one year older, having been frozen in over a winter. Sailing back to the shore on a bright clear day we saw the high peaks of the land where we had been enveloped in clouds for three days.

Our course from that time on was in waters which are not only uncharted and unsounded but which are practically unknown except for the fact that they are infested with hundreds of shoals and islands. It may be noted that this is the only time a vessel has sailed along northern Labrador without a pilot. Had we taken one it would have been impossible for us to cover the territory we did, because they sail from island to island and will not sail at night. We worked north past the Region of the Iron Strand and the Four Peaks. The latter comprise what is supposed to be the highest land in Labrador. As they are several miles back of the coast, it is difficult to get a correct measure of their height. They are estimated to be about 7000 feet.[5] The true height will not be known until some one arrives on the scene well appointed for enduring hardship and with time to spare, and the climbs will not be easy: the Peaks in the upper 3000 feet appear to be steep-sided pyramids.

At the mouth of Ryan's Bay were two Newfoundland fishing vessels. This is their farthest north. The Ryan's Bay fiord has heretofore been unexplored; we stayed here two days. The sides are steep hills rather than cliffs. On the north bank is the characteristic evidence of elevation along the Labrador coast, here taking the form of a fine series of wave-cut terraces reaching to a height of 300 feet above sea level. This fiord is not so deep as Saglek and Nachvak. It is a mile wide, runs four miles northwest, turns abruptly, and runs fifteen miles southwest where it ends with a high delta 200 feet above sea level. The meandering river has cut its way down through this alluvium to the rock bottom. A party worked back twenty miles from the bay, passing two large lakes six and eight miles in. They were stopped by a large range running north and south and forming the divide between Ungava Bay and the Atlantic. Raised beaches were observed most of the way, and several deserted Eskimo camps eight miles from the bay. We noted a glacier on the south side of the bay about halfway in. The cirque was about one-third full of ice, and the fall as typical as those of the glaciers of Mt. Rainier, showing distinctly the much crevassed blue-gray ice and with distinct *Bergschrund*. Mountains about this region seem to be 4000–6000 feet; our plans for ascent, however, were spoiled by thick fog. Although this region is only thirty-five miles north of Nachvak there is a distinct difference in the flora.

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[5] Elevations under 3000 feet were measured with an altometer; those above were estimated. The writer, however, is of the opinion that 7000 feet is a conservative estimate for the Four Peaks.

On August 26 we continued north, bound for Ekortiarsuk, a fiord never before entered by white man as far as the record goes. Sailing was now conducted with great care. Vessels bound for Hudson Bay sail twenty miles offshore to clear the shoal-infested waters of this north coast. We had always to have a man aloft and two men constantly sounding with lead and line. Although the water is clear, luxuriant growth of kelps makes the ledges invisible. Strong squalls from the northwest were frequent.

Fog held us up in northern Eclipse Harbor a day and a half. We sailed into Ekortiarsuk on August 28. Shoal water and many islands at the entrance of the bay explained why no vessel had ever been inside. After working northwest through the broad bay for two miles, we came to the entrance of the fiord proper. It runs southwest for twelve miles, then west for six miles, where it ends in a broad bay a mile wide, very shallow compared with the heads of fiords farther south, and with side walls not so sheer. A branch fiord enters the main one from the west about eight miles from the entrance. There are many nubbles or low hills along the shore, a feature not so characteristic of other bays. Fog prevented us from gaining any conception of the top of the land save that it appeared to be much lower than about Nachvak and Ryan's Bay. Passing to the north from Saglek to Nachvak, to Ryan's, and to Ekortiarsuk there is an interesting gradation in the fiords from steep cliffs and very deep water to gently sloping hills and shallow water.

When ready to start south we were again held up four days with heavy fogs. We had hardly been prepared for the amount of fog experienced throughout our expedition in view of the reports of previous visitors. Rain fell every day, but only occasionally did we have heavy storms of long duration. Above 3000 feet the precipitation was always snow. Prevailing winds in September are supposed to be strong and enduring westerlies, but we experienced only two light westerlies. The temperature at sea level ranged from 33° to 50° F. During the night it was usually about 34° F.

In all of the fiords we made extensive collections of plant and animal life, which are now being worked up.[6] Our oceanographical data, it is hoped, will prove to be of aid to the International Ice Patrol.

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[6] A paper by the writer, "Interesting Plants of Northern Labrador," appeared in the April, 1927, number of *Rhodora*.

THE LABRADOR BOUNDARY DECISION

Hon. Sir Patrick T. McGrath, K. B. E.
President of the Legislative Council
of Newfoundland

ON March 1, 1927, the Judicial Committee of the Imperial Privy Council, the Tribunal in London which had been adjudicating the dispute between Canada and Newfoundland regarding the boundary of their respective jurisdictions in Labrador, rendered its decision. The Canadian claim was, in effect, that the "coast of Labrador" extended from Cape Chidley in the north to the bay of Blanc Sablon[1] in the southwest a mile inland from the high water level. The Newfoundland claim was that the "coast" should be the area from the Atlantic to "a line drawn due north from Anse Sablon as far as the 52 degree of North latitude, and should be traced from thence northwards to Cape Chidley along the crest of the watershed of the rivers flowing into the Atlantic Ocean." The decision of the Judicial Committee was to the effect that Newfoundland had, in the main, made out its case and was entitled to the ownership of the Atlantic watershed of the Labrador Peninsula, though two trifling diversions in favor of Canada were included in the judgment.

The dispute had been at issue for nearly twenty-five years, counting from the time preliminary litigation in the civil courts began, but as a diplomatic problem it extended back another twenty-five years, because the United States Government, in 1874, sought and secured from Canada a pronouncement with respect to it. Historically, the roots of this problem may be said to go back to the early days of the discovery of the region we now know as Canada, and, in order to appreciate how the dispute arose, it is necessary to refer briefly to a few landmarks in the early history of North America.

The Island of Newfoundland

In 1497 John Cabot sailed to Newfoundland from the west coast of England, an enterprise inspired to develop the British Navy, which marked the reign of Henry VII and was the keynote of British policy in relation to Newfoundland until the nineteenth century. During the years between 1497 and 1583 Portuguese and Basque fishermen and others from Normandy and Brittany resorted to the Newfoundland coast often in greater numbers than the English. In

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[1] The form Blanc Sablon has generally replaced Ance, or Anse, Sablon for the last hundred years.

1583 Sir Humphrey Gilbert obtained a commission from Queen Elizabeth as Governor of the Island and a large grant of land there. In Hakluyt's words, "he was the first of our nation that carried people to erect an habitation and government in these northerly countries of America." But his attempt at colonization failed, and he himself perished on the return journey.

In 1610 a further attempt at colonization was made by Guy's Association, which obtained a Royal Charter from James I granting them territory between Cape St. Mary and Cape Bonavista. Under the protection of this Charter, John Guy of Bristol settled in Conception Bay, issuing decrees as Governor. In 1698 the system of fishing admirals was introduced. The first captain to arrive from England at any harbor for the spring was *ipso facto* admiral for the season, the second vice admiral, and the third rear admiral. The admirals performed not only executive but judicial functions, a right of appeal being reserved to the officer commanding the convoy of the King's ships.

Canada and New France

Meantime, in 1534, Cartier had made his first voyage to the Bay des Chaleurs and Gaspé. In the next year occurs the first mention of "Canada," the river now known as the St. Lawrence being referred to as the Grand River Hochelaga, "the waterway of Canada." In 1603 came Champlain, who can fairly be called the founder of New France. In 1608 he formed a settlement at Quebec and later at Three Rivers. In 1641, shortly before his death, a third settlement was formed at Montreal. These three sparsely populated settlements—there were only two hundred persons in Quebec in 1641—formed the districts upon which the French organization was based, and the plans made by General Monckton and Lord Amherst after the fall of Quebec in 1759 show that the same division was maintained by the British until Quebec was made into a province by the Royal Proclamation of 1763.

The Hudson's Bay Company

During the latter half of the sixteenth century Frobisher saw Hudson Strait, and Davis crossed its mouth and sailed down the coast of Labrador to the fifty-second degree of north latitude, landing at what are now known as Davis Inlet and Hamilton Inlet. In 1610 Hudson sailed into Hudson Bay.

In 1670 the Hudson's Bay Company obtained from Charles II a royal charter giving them sole rights of trade and commerce of all those seas, straits, bays, rivers, lakes, creeks, and sounds in whatsoever latitude they should be, that lie within the entrance of Hudson Strait, together with all the lands and territories upon the countries, coasts, and confines of the seas, etc., as foresaid, that were not actually possessed by or granted to any of His Majesty's subjects or possessed by the subjects of any other Christian Prince or State. The Company were also granted the proprietorship of the territories so described and the full right and power to govern such territories.

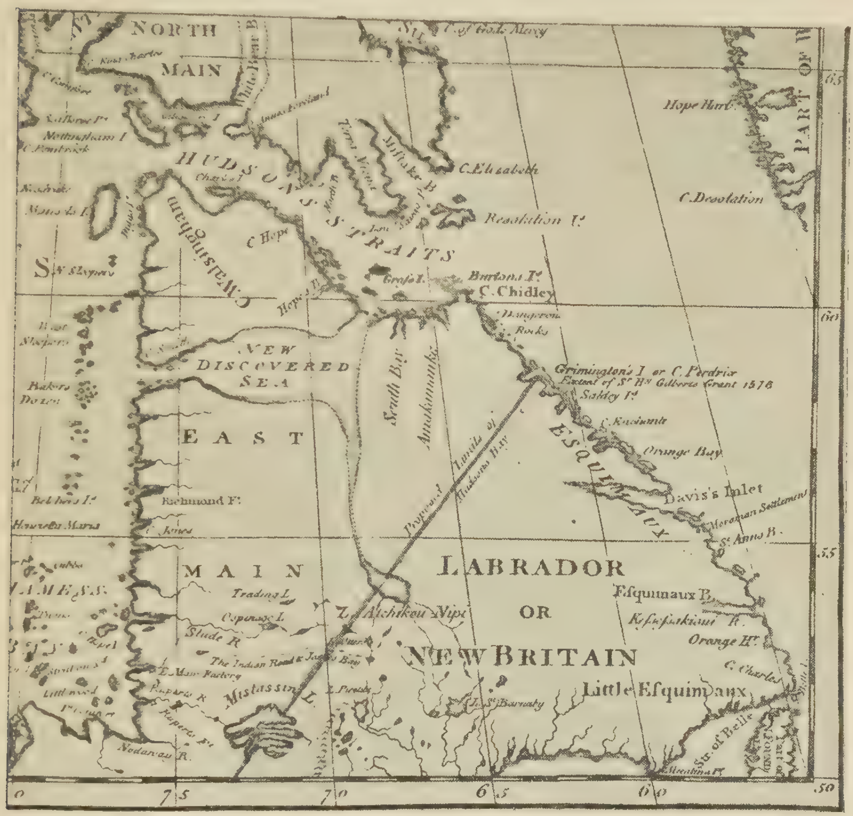

FIG. 1—Reproduction on a reduced scale of a portion of the inset "A New Map of Hudson's Bay and Labrador" on Mitchell's "Map of the British and French Dominions in North America," 1755.

It is unnecessary to trace in detail the history of the conflicts which followed between the British established under the authority of this Charter on the shores of Hudson Bay and the French who were making their way north to Hudson Bay from New France. In 1697, by the Treaty of Ryswick, the French obtained from Great Britain a cession of the territories bordering on Hudson Bay. But war soon broke out again, and in 1713, by the Treaty of Utrecht, France restored to Britain "the bay and streights of Hudson, together with all lands, seas, seacoast, rivers, and places situate in the said bay and streights, and which belonged thereunto, no tracts of land or sea being excepted which are at present possessed by the subjects of France." The Treaty further provided for both sides to determine by Commissaries, to be forthwith named by each, the limits which were to be fixed between the said Bay of Hudson and the places appertaining to the French, which limits both the British and French subjects should be wholly forbidden to pass over or thereby to go to each other by sea or by land. The same Commissaries were also to describe and settle in like manner the boundaries between the other British and French colonies in those parts. Commissaries were duly appointed, and proposals and counter-proposals were made; but no definite decision was ever reached.

The Treaty of Utrecht further declared Newfoundland to belong in exclusive sovereignty to Great Britain but reserved fishing rights to the French between Cape Bonavista and Cape Rich.

The Position on the Labrador Peninsula in 1763

The Labrador peninsula connotes all the area, some 511,000 square miles in all, east of a line joining James Bay and the St. Lawrence River. Prior to 1763 the position was that the only territories on the Labrador peninsula subject to the British Crown were those granted to or acquired by the Hudson's Bay Company under their Charter of 1670 and that, though the boundaries of those territories were not definitely ascertained, they did not extend anywhere (save possibly in respect of the area between Cape Chidley and Cape Grimington) farther into the interior than the height of land, which formed their boundary in 1857.

In 1763 the Labrador peninsula was regarded as of importance almost solely on account of the fisheries carried on on the north shore of the Gulf of St. Lawrence, mainly for whale, sea cow (walrus), and seals; in the Strait of Belle Isle, and each year a little farther north of this strait, principally for cod; and on the rivers along all the extent of the coast mentioned, for salmon. Before the Treaty of Paris, 1763, the French made grants of territory along the northern shore of the Gulf of St. Lawrence to French subjects; few if any of such grants extended more than four leagues into the interior, and but one of them seems to have extended farther east than Belle Isle. Traffic with the native inhabitants in fur and hunting in the interior were interests not wholly overlooked by the French and English, but they were of subsidiary importance compared with the fishing. The seaboard of the country was bleak and uninviting, swampy and unsuitable for cultivation, and highly inaccessible.

The native population was small and migratory. Eskimos dwelt along the coast, particularly north of the Strait of Belle Isle (there are now no Eskimos south of Hamilton Inlet). Of the Indian tribes the Montagnais, the "Mountaineers," lived farther inland principally south of the Hamilton River, with their main hunting grounds near the North West River, though they hunted on both sides of the height of land; the Nascopies occupied the central portion of the area south of Hudson Strait. The numbers of these native inhabitants have varied little since 1763 and now are probably between two thousand and four thousand in all. In the area now claimed by the Newfoundland Government no Europeans were settled. Even today the interior country is largely unknown, and between the Saguenay River and Cape Chidley there are no settlements out of sight of sea or river water; while even in the western part of Canadian Labrador, between Natashquan and the Saguenay, apart from the most rudimentary agriculture and a pulp mill established some ten years ago at Seven Islands, there is no industry except fishing and furring.

Labrador Attached to Newfoundland

Shortly after the Treaty of Paris had been signed in 1763 the eastern section of Labrador, from the entrance of Hudson Strait to the St. John River, which enters the sea near the western end of Anticosti Island, was attached to the Governorship of Newfoundland, and after that the English authorities set to work to dispose of the rest of the conquered territory. A Royal Proclamation was issued, creating four colonies—Quebec, East Florida, and West Florida on the mainland, and Grenada in the West Indies—and reserving for the use of the Indians, who had been on terms of amity with Britain, the remainder of the vast French empire which had now come into English hands. In this Proclamation it was set out that:

> To the end that the open and free fishery of our subjects may be extended to and carried on upon the coast of Labrador and the adjacent islands, we have thought fit, with the advice of our said Privy Council, to put all that Coast from the river St. John's to Hudson's Streights, together with the islands of Anticosti and the Madelaine and all other smaller islands lying upon the said coast, under the care and inspection of our Governor of Newfoundland.

In these two varying descriptions, one attaching the territory to the Governorship of Newfoundland, without any qualifications, and the other placing it under the care and inspection of the Governor of Newfoundland, "in the order that the free and open fishery of our subjects may be carried on," will be found the bone of contention between the Governments, as will be shown later. In 1774, after the Labrador territory had been eleven years part of Newfoundland, the whole of it was reannexed to Quebec, though there is evidence, from the discussion attending the passage of the statute which so transferred it, that the intention of the English Government was merely to return to Quebec the section from Belle Isle Strait westward. The reason for this was that the fisheries and fur-trading in that area were carried on by people residing on the seaboard; whereas these industries on the Atlantic front were prosecuted mainly by fishing vessels manned by crews from the British Isles direct, or with Newfoundland as an advanced base. In 1809, the ascendency of the latter having increased meanwhile, the whole territory was again transferred to Newfoundland, as the experience of thirty-five years had shown that it was impossible for the Government of Quebec to control the region—indeed, the only effective control was exercised by the Commander of the Naval Squadron which protected the fishing fleet, he also being the Governor of Newfoundland. Finally, in 1825, an arrangement was made whereby the area between the St. John River and Ance Sablon, at the western extremity of Belle Isle Strait, was reannexed to Quebec, the remainder being left to Newfoundland, which still retains it.

THE GROWTH OF QUEBEC PROVINCE

The Royal Proclamation of October 7, 1763, which created the Colony or Province of Quebec, fixed its boundaries thus:

> Bounded on the Labrador Coast by the river St. John, and from thence by a line drawn from the head of that river, through the lake St. John, to the south end of the Lake Nipissim; from whence the said line, crossing the river St. Lawrence, and the Lake Champlain in forty-five degrees of north latitude, passes along the high lands which divide the rivers that empty themselves into the said river St. Lawrence, from those which fall into the sea . . .

In 1774 the Province was enlarged. The western boundary was carried north to strike that of the Hudson's Bay Company, and, as the whole of "the Coast of Labrador," whatever that meant, was reannexed to Quebec, it would seem to follow that the whole of the peninsula east and north became part of Quebec to the watershed draining into Hudson Bay, while the territory beyond the crest of the terrain belonged to the Hudson's Bay Company. Then it would equally seem to follow that in 1809 this same area was passed back to Newfoundland and that she retained it in 1825, except for the section between Ance Sablon and the St. John River.

In 1867 came an important development consummated in 1869. The Hudson's Bay Company sold to the Canadian Government all its territory reserving only certain choice sections in and about towns and along roads. In 1898 Quebec secured an extension of her northern boundary from the Laurentian watershed to the line of the East Main and Hamilton Rivers, the one debouching into Hudson Bay on its eastern side, and the other debouching into the Atlantic; and in the Canadian statute effecting this enlargement the boundary was carried along the center of the Hamilton River to a point near Rigolet, and thence southward to Blanc Sablon. Finally, in 1912, the remaining portion of what was previously known as the Ungava District, from the line of the East Main and Hamilton Rivers northward to Hudson Strait, was also added to the Province of Quebec, and its eastern boundary was declared to be the western boundary of the territory lawfully in the possession of Newfoundland.

THE BOUNDARY ISSUE ARISES

The reason for this last development was that between 1898 and 1912 the two countries had come to grips over the region. Newfoundland assuming, as always, that the territory was hers, began in the nineties to issue grants of land for mineral and timber development;

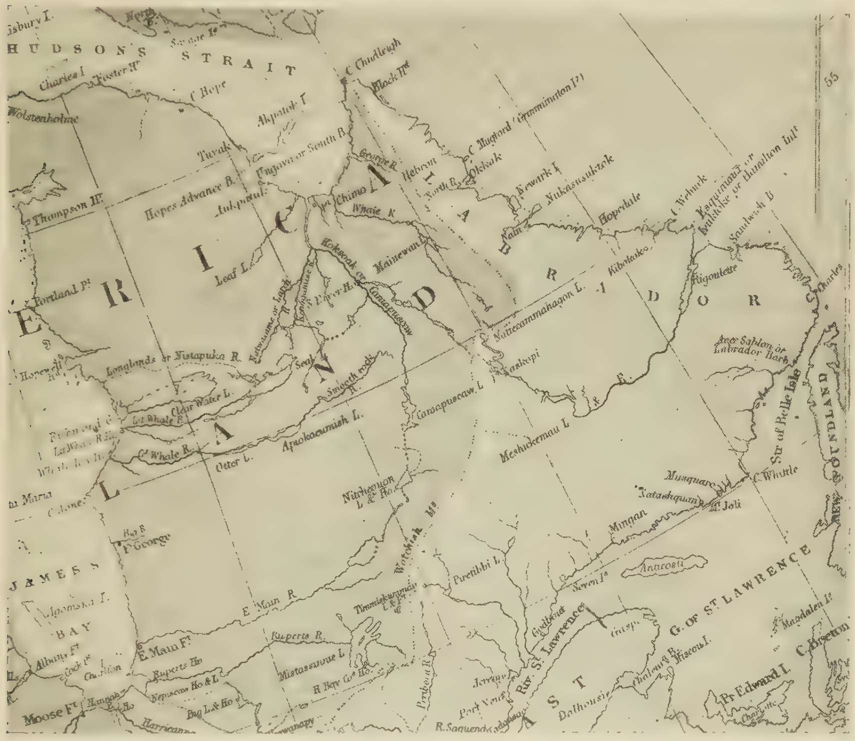

FIG. 2—Reproduction on a reduced scale of a portion of Arrowsmith's "Map of North America," 1857, showing the territories claimed by the Hudson's Bay Company.

and, when some thirty years back the modern method of making paper out of spruce wood began to take form, parties sought and secured timber-cutting licenses from her in different parts of Labrador. One concern obtained such a right on the Hamilton River in 1902, and when this took place the Quebec Government intervened, claiming that the south bank of the river belonged to them, and enforced their view by sending a steamer to the region with government officials on board, who seized the logs of the lumber company and forbade further activity. Newfoundland, having given the license, had no alternative but to back the lumbermen before the Quebec courts, where civil action was taken by the Quebec authorities. In the meantime, the two governments and the Imperial authorities opened negotiations for a settlement of the whole question by its submission to the Privy

Council. This was agreed to, and the work of preparing the case was put in hand. Delay followed from various causes. During the war there was a complete cessation of activity, and political convulsions in Canada and Newfoundland, from time to time, contributed their quota. Finally, the case was put to trial in October, 1926, and, as already said, the decision was given on March 1, 1927.

The Issue Before the Tribunal

The trial was before the Judicial Committee of the Imperial Privy Council. This committee, composed of the reigning Lord Chancellor, his predecessors in that office, and other eminent judges, both of the mother country and the oversea possessions, is the last court of appeal for all the British dominions except Great Britain and Northern Ireland. The Lord Chancellor, Viscount Cave, because of the importance of the case, took the presidency of the Tribunal. The other four members included Lord Haldane, who had participated in the adjudication of three cases between the Province of Quebec and the Dominion of Canada regarding fishing and other rights in that Province, and Lord Finlay, who had had experience in the dispute respecting the North Atlantic Fisheries between Great Britain (representing Canada and Newfoundland) and the United States arbitrated at the Hague in 1910, and also in the arbitration over the boundaries of British Guiana.

The hearing occupied nearly four weeks and formed a loadstone which attracted to the Council Chamber leading lawyers of both England and her colonies, for the Imperial Conference of 1926 was proceeding in London at the same time, and virtually all the delegates from the different oversea possessions that were gathered for the occasion availed themselves of the unique opportunity afforded by the trial of seeing the Judicial Committee in action dealing with a case of outstanding interest to the colonies in general.

So important was the precise nature of the pronouncement desired from the Tribunal that the legal authorities on the two sides spent five years in correspondence respecting it, ultimately agreeing that the question to be submitted to the Judicial Committee should be as follows:

What is the location and definition of the boundary as between Canada and Newfoundland in the Labrador peninsula under the Statutes, Orders in Council, and Proclamations?

To assist the Tribunal in deciding this question both sides accumulated such a mass of documentary evidence[2] in the form of printed material and ancient and modern maps, as has never been approached in the history of the British Courts; and for that reason, the decision was awaited with the keenest interest, not lessened by the fact that one party to the case was the populous, wealthy, and influential Dominion of Canada, stretching from ocean to ocean and occupied by some ten million people, while on the other side was the little colony of Newfoundland, with a population of only about a quarter of a million, the antithesis of Canada in each of these respects.

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[2] The documents presented by the two sides numbered 1631 and were included in eight volumes comprising 4200 pages, besides which each side had an atlas of 50 to 60 maps. Two indexes, one alphabetical and one chronological, were also provided; and printed reports of the argument at the trial ran to three more volumes of 500 pages each. Lastly, the judgment itself, a masterly production, an exhaustive review of the whole subject, covered 23 printed pages and exceeded 10,000 words.

SEABOARD STRIP OR WATERSHED

The issue between the two countries, presented to the Tribunal for determination, was embodied in the question, What was meant by the phrase, "the coast of Labrador," or, as some of the documents had it, "all the coasts of Labrador," as used in the official instruments of the period; or, in other words, was the "coast" a mere strip of seaboard, such as would be required merely for the uses of the fishery, as Canada contended, or was it the watershed, as Newfoundland contended, accepting the word "coast" in its larger rather than its restricted meaning?

The meaning of the term "coast" was the subject of intensive investigation; sacred and profane literature was invoked in its interpretation. Thus the authorized version of the Bible of 1611 was quoted by Newfoundland in support of its contention that the word "coast" as used in connection with Labrador in the pertinent documents meant a "country" and not a mere strip of seaboard, as for instance, "Every place whereon the soles of your feet shall tread shall be yours; from the wilderness and Lebanon, from the river, the river Euphrates, even unto the uttermost sea shall your coast be" (Deuteronomy, 11:24). "Then Herod, when he saw that he was mocked of the wise men, was exceeding wroth, and sent forth, and slew all the children that were in Bethlehem, and in all the coasts thereof, from two years old and under" (St. Matthew, 2:16).

Numerous other instances from dictionaries, geographies, and law books of the use of the word in the same sense were included in the documents, and the writer of the editorial on the case in the London *Daily Telegraph* on the morning after the decision said: "It may be recalled—though the fact is hardly evidence, perhaps, for a legal tribunal—that the whole extent of Hades was 'the dreary coast of Pluto,' for the purposes of Pope's translation of Homer."

In the discussion over the term coast it was pointed out that vast areas of territory were known as "coasts"—the Gold Coast, the Coromandel Coast—a usage arising from the common method of occupation of a new country. It has been generally admitted that occupation of the coast carries with it a right to the whole territory drained by the rivers emptying thereon, unless the hinterland already enjoys other effective occupation. That this was intended to apply in the case of Labrador is suggested by the fact that on the one side the Hudson's Bay Company's territory, by the original grant, comprised all the lands drained by the rivers that flow into Hudson Bay or Strait, and, on the other side, that the southern boundary of the Province of Quebec ran along the crest of the mountains which separated the rivers flowing into the St. Lawrence from those flowing into the Atlantic.

Moreover, by the Proclamation of 1763 the Province of Quebec is described as bounded on the north by a line drawn from the head of the St. John River to the westward, a description which leads to the inference that the land on the east or left bank of the St. John from its head to the sea had been already allotted to the Government of Newfoundland. By the Act of 1825 it was provided that so much of the said "coast" of Labrador as lies to the westward of a line to be drawn due north and south from the bay or harbor of Ance Sablon inclusive as far as the fifty-second degree of north latitude should be reannexed to and made part of the Province of Lower Canada. Such a line would penetrate the interior of the country for about forty miles, and the land to the westward would in some of its parts cover a distance of over one hundred miles from the sea; wherefore, it would seem that the language of this enactment, construed in its plain and natural meaning, points directly to the inference that the expression "coasts of Labrador," as used in 1763 and 1809, was understood by the British Parliament in 1825 to have comprised the interior of the country back to these limits.

Furthermore, it was held that Newfoundland's case did not depend on the use of the word "coast"; that alternatively the region granted to her, whatever it was, was repeatedly referred to as the "territory" of Labrador; and that this "territory," according to the phraseology of the official documents, was something more than a mere strip. Thus reference was made in these early documents to the "territories of Labrador" and to the planters or inhabitants resident there, authorizing successive governors to appoint judges and justices of the peace to hold courts of Quarter Sessions, and to erect on the "coast" court-houses. The Tribunal held it to be plain that a criminal jurisdiction limited to a narrow coastal strip would be very difficult to exercise. Further, the judgment pointed out that the same instructions required the governors to report, not only as to the protection of the fishery, but also as to the security of the country and the establishing and carrying on of commerce with the Indians inhabiting the "coast" of Labrador. These and the directions for protecting the timber from waste, for reporting as to the number of inhabitants and of the furs taken by them, and for describing the improvement of the land, which apply to Labrador, are appropriate to a government extending into the interior.

The Canadian proposal to restrict Newfoundland to a one-mile strip running along the foreshore over the whole territory would present immense difficulties in application. Some parts of this proposed ribbon of land lie at the summit of high land not accessible from the sea and hence would be of no use to the fishermen. On the other hand, in places where, owing to the existence of sea beach or of an inlet, opportunities for landing are available, a limit of one mile would be found insufficient. For the purpose of obtaining wood for repairs a strip three to five miles deep would possibly be needed. Still again, there are places where a broad peninsula is joined to the mainland by a neck of not more than two miles in width, and in each of these instances the one-mile strip would meet in the neck of the peninsula and cut off by an interposed barrier of Newfoundland soil access to the Canadian enclave on the broader part of the promontory. Therefore, the Tribunal argued that the Crown could not have intended to annex to Newfoundland an area of that shape and character, to refer to it as a "territory," and to establish a form of government there, and that this view would be fantastic if the strip were carried round the shores of Hamilton Inlet and Lake Melville, 150 miles back from the ocean.[3] To the argument that the territory claimed by Newfoundland is over twice the size of Newfoundland itself, it was replied that the territory in question, when compared with the vast regions with which the British Government was dealing at the time, was relatively small in area and infinitesimal in value.

Occupation and Control

Evidence of jurisdiction on the part of Newfoundland in the years following 1763 showed that the annexation of the "coast" had always been understood and treated as including the whole area lying between the sea and the watershed. The Tribunal emphasized the view that, before the final Act dealing with this region was passed, sixty years had elapsed and that these exercises of jurisdiction must have been in the mind of Parliament in the meantime.

In 1765 the Unitas Fratrum, a society of Moravian missionaries, asked for four tracts of land on the coast of Labrador, containing together about 400,000 acres, with a view to the settlement there of missions to the Eskimos; and, with the approval of the British authorities, certain missionaries were sent out and received the support and protection of Governor Palliser. The first grant was made in 1769 and directed the Governor of Newfoundland to give the grantees all reasonable assistance and support in forming their establishment. In

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[3] Compare the note "Lake Melville, True Lake or Inlet of the Sea?" in the Record section of this number of the *Review*.—Edit. Note.

1774 two other similar grants were sanctioned and committed to the Governor of Newfoundland to be carried out, and in 1821 a fourth grant of a like nature was made to the same society. These lands penetrated into the country far beyond the suggested limit of one mile from high-water mark and in the case of the most northerly of them to a distance of about thirty miles from the shore. The Tribunal held that these grants, connected as they were with the government of Newfoundland, were consistent only with the existence of a Newfoundland jurisdiction extending beyond the littoral strip, observing that "it is hard to believe that when, in the year 1809, Parliament restored to Newfoundland the Coast of Labrador, it intended to divide the Moravian settlements then in existence, placing a small fraction of them (one mile in width), under the jurisdiction of the Colony, and leaving the remainder to Canada."

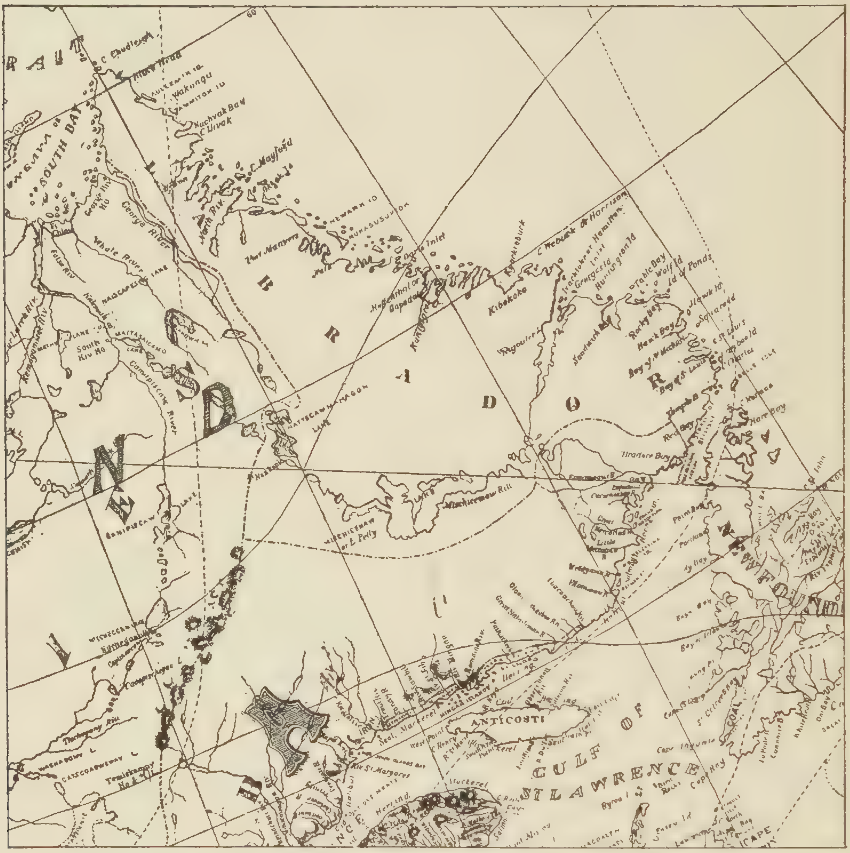

FIG. 3—Reproduction on a reduced scale of a portion of the map sent by the Canadian Government to the United States Government in 1874, showing the boundary between Labrador, "annexed to Newfoundland," and the Dominion of Canada. From a photostat copy kindly supplied by the Library of Congress, Division of Maps.

Another evidence of jurisdiction is that, in 1774, John Agnew and others, having petitioned for a grant of mines and minerals to be discovered on the "coast" or "country" of Labrador, between the St. Lawrence River and Hudson Strait, the King in Council approved of the grant to them of all such mines and minerals "upon such parts of the sea coasts of Labrador as lie within sixty miles of low-water mark of the open sea," a grant which, says the tribunal, "appears to treat the 'coast' as extending far inland from the shore."

The next point is as to the administration of justice on the coast. This throughout has been under the direction of the Governor of Newfoundland, in the early years by Naval Surrogates exercising their functions on board their vessels or from some place close to the seashore. By the Act of 1809 the Jurisdiction of the Supreme Court of Newfoundland was extended to Labrador; in 1811 the institution of surrogate courts for that purpose was authorized, and in 1824 the Governor of Newfoundland was empowered to institute a court of civil jurisdiction on the "coast" itself and appointed a judge therefor; and records were put in evidence showing that the judge so appointed exercised his functions at various places in the Labrador territory, some of which—the head of Hamilton Inlet, for instance—would have been far outside his jurisdiction if it had been limited as claimed by Canada. In 1834 the Legislature of Newfoundland, which had been established, abolished the court on the ground of expense; but the same Legislature in 1863 revived the court, which continued till 1874 when it was again discontinued for the same reason, each of these judges, in addition to performing his judicial duties, making a report from time to time on various questions relating to the territory, including roads, schools, churches, and the fur trade.

Similarly, customs duties have been levied on behalf of the government of Newfoundland on goods disembarked at Labrador from about the year 1826 to the present time, and the right of the government to collect such duties has from time to time been affirmed by the Secretary of State in London. In 1864 Donald Smith (afterwards Lord Strathcona), who was in charge of the Hudson's Bay Company's trading station at North West River, agreed, after some demur, to pay the duties on goods at that place; and such duties have since been regularly paid. Finally, the Tribunal makes the pertinent comment that "no evidence was given of any exercise of a Canadian jurisdiction in any part of the territory in dispute."

Evidence in a Communication to the United States

The United States contributed indirectly to the solution of the dispute by some diplomatic despatches going back to 1874, wherein it sought information as to the ownership of Labrador. To this inquiry Lord Dufferin, as Governor-General of Canada, sent his reply through Sir Edward Thornton, the British Ambassador in Washington, the reply being really a copy of the report of a Committee of the Privy Council approved by the Governor-General in Council on November 1, 1874, which was in the following terms:

> In a despatch dated 20th June, 1874, from Sir Edward Thornton to Your Excellency, inclosing a communication from the Hon. Hamilton Fish, Secretary of State at Washington, desiring to be informed whether any part of Labrador is separated from the jurisdiction of either the Dominion of Canada or that of Newfoundland.
>
> The honorable the secretary of state, to whom this despatch, with inclosures, has been referred, reports that the boundary-line between the Dominion of Canada and Labrador is a line drawn due north and south from the bay or harbor of Ance au Blanc Sablon, near the straits of Belle Isle, as far as the fifty-second degree of north latitude; that Labrador extends eastward and northward from that point to Hudson's Straits.
>
> That the division-line in the interior separating Labrador from the Dominion of Canada has only been defined as far north as the fifty-second degree of north latitude, but it has been assumed that the boundary-line in the interior would have taken the direction laid down on the accompanying map, which follows the height of land.
>
> That Labrador, with the islands adjacent thereto, is annexed to Newfoundland, and under the government of that Island.
>
> Attached to the report of the secretary of state are extracts from the imperial statute bearing on the question, and a map showing the exact boundary on the coast and the assumed boundary in the interior.
>
> The committee recommend that a copy of this minute, with map and extracts from the imperial statutes above alluded to, be transmitted to Sir Edward Thornton for the information of the United States Government.[4]

It will be observed that this map (see Fig. 3), a copy of which was put before the Tribunal by Newfoundland, was sent to Washington as "showing the exact boundary on the coast and the assumed boundary in the interior"; and the Tribunal observes that it "assigns to that territory the exact boundaries claimed for it on behalf of Newfoundland." As regards the whole series of maps issued by departments of the Canadian Government from 1874 down to 1900, the Tribunal expresses itself in these terms:

> The maps here referred to, even when issued or accepted by departments of the Canadian Government, cannot be treated as admissions binding on that Government, for even if such an admission could be effectively made, the departments concerned are not shown to have had any authority to make it. But the fact that throughout a long series of years, and until the present dispute arose, all the maps issued in Canada either supported or were consistent with the claim now put forward by Newfoundland, is of some value as showing the construction put upon the Orders in Council and statutes by persons of authority and by the general public in the Dominion.[5]

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[4] Papers Relating to the Foreign Relation of the United States, Transmitted to Congress . . . December 6, 1875, Washington, 1875, Vol. 1, p. 644.

[5] In the Matter of the Boundary between the Dominion of Canada and the Colony of Newfoundland in the Labrador Peninsula . . . Report of the Lords of the Judicial Committee of the Privy Council, delivered the 1st March, 1927, London, 1927, p. 22.

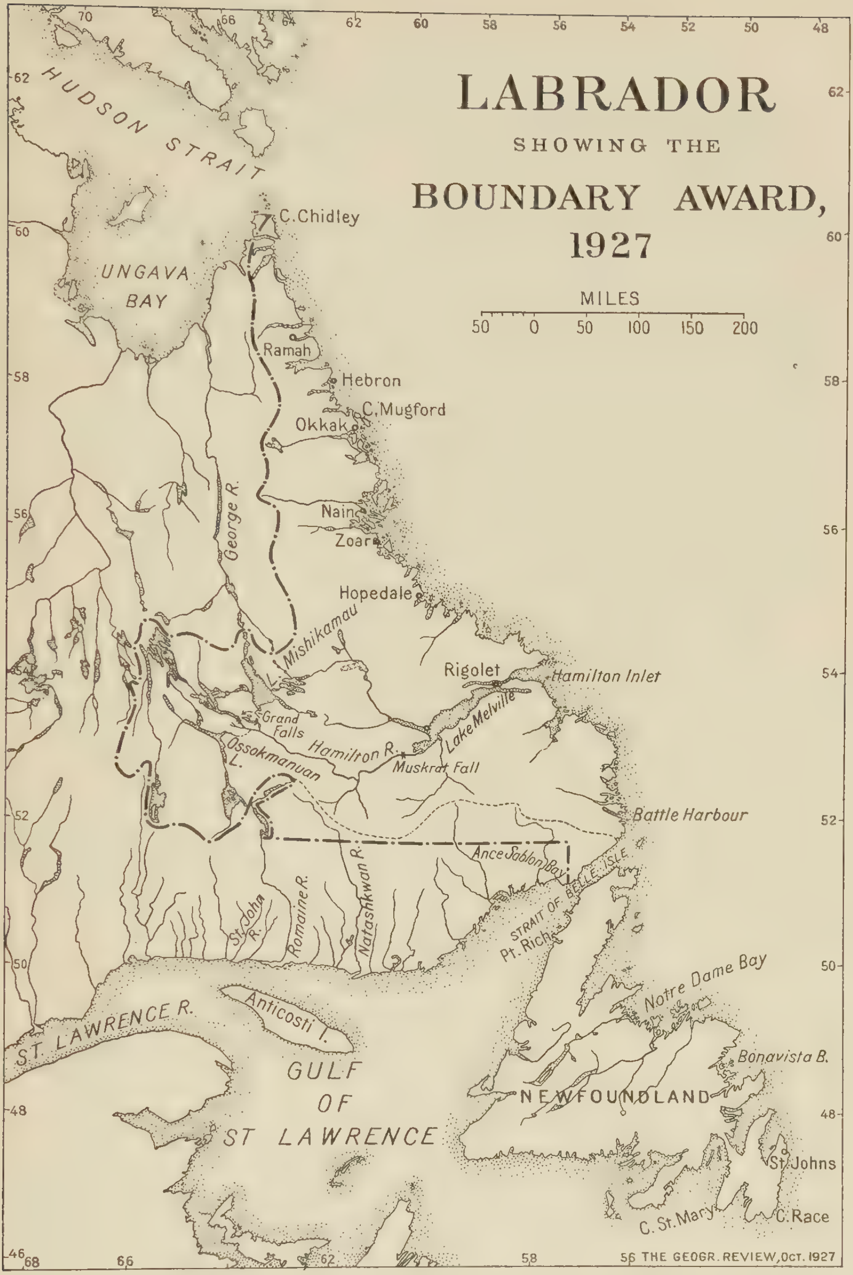

FIG. 4—The Labrador boundary according to the Judgment given March 1, 1927. Scale of the map a little over 1: 1,000,000. No arrangements have as yet been made for the demarcation of the boundary. As Mr. A. R. Hinks points out in the *Geographical Journal* for July, 1927 (pp. 42–43), this will not be easy, since it calls for identification of the watershed in the complicated drainage of a recently glaciated plateau.

The decisions of the Judicial Committee take the form of a Report to the King in Council, by whose Order in Council it is then approved and becomes of binding effect. The Tribunal rendered its finding over the Labrador question thus:

> Upon the whole, their Lordships, having considered the facts and arguments put before them with the care which is necessary in a matter of such grave importance, have come to the conclusion that the claim of the Colony of Newfoundland is in substance made out. . . . For the above reasons their Lordships are of opinion that, according to the true construction of the Statutes, Orders in Council and Proclamations referred to in the Order of Reference, the boundary between Canada and Newfoundland in the Labrador Peninsula is a line drawn due north from the eastern boundary of the bay or harbour of Ance Sablon as far as the fifty-second degree of north latitude, and from thence westward along that parallel until it reaches the Romaine river, and then northward along the left or east bank of that river and its head waters to their source and from thence due north to the crest of the watershed or height of land there, and from thence westward and northward along the crest of the watershed of the rivers flowing into the Atlantic Ocean until it reaches Cape Chidley; and they will humbly advise His Majesty accordingly.[6]

The Tribunal made two inconsequential changes in Canada's favor at Blanc Sablon. Here usage had fixed a river running into the center of the harbor as the boundary, but the Tribunal held that, following the words of the 1825 Act, which attached to Quebec the strip westward of the bay or harbor of Ance Sablon inclusive, the boundary line should run north from the eastern point of the bay to the 52nd parallel, thus giving Canada a strip one and one-half miles along the strand and 40 miles deep, or 60 square miles in all, with Woody Island (area 1 square mile) lying off this harbor and also held by Newfoundland previously. In all other respects Newfoundland's claim was maintained.

Value of the Labrador Region

The natural resources of the Labrador area awarded to Newfoundland are considered to be very great. Of the total area of 100,000 square miles 60,000 are estimated to be forested, and of this more than half to be capable of producing timber of commercial value. Canadian lawyers engaged in the Boundary Case estimated the value of the forest wealth of the area to be $250,000,000. Mr. E. M. Kindle, of the Canadian Geological Survey, in an article in the *Geographical Review*[7] refers to:

> . . . . the heavily forested vast interior Labrador, traversed by countless streams and dotted with thousands of lakes. In this interior region salmon and trout fishing take the place of cod fishing. A summer climate replaces the ice-chilled coastal climate, and forests cover both mountains and valleys.

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[6] *Ibid.*, pp. 22, 23.

[7] E. M. Kindle: Notes on the Forests of Southeastern Labrador, *Geogr. Rev.*, Vol. 12, 1922, pp. 57–71.

> Labrador will probably play a very important rôle in supplying forest products for the world market of the future." . . . the Lake Melville waterways "are of peculiar importance in this connection because they afford about 200 miles of navigable waters which are usable by seagoing vessels . . . an important element in keeping transportation costs at a low figure.

The peltry wealth is also considerable. As to this Kindle goes on to say:

> At present the forests supply only by-products in the shape of fur-bearing animals. In one sense the annual fur catch may be regarded as a forest by-product. The heavy forests produce what is said to be the finest grade of fur known in the north. . . . Minks, weasels, and martens are the more common fur-producing animals. Red, cross, silver, and white foxes are trapped—the last generally being found only near the coast. The otter, lynx, and beaver are also present. This region is near the southern limit of the range of the polar bear, which is sometimes taken on the seacoast; but it, like the seal, belongs to the sea rather than to the forests.

Quite as valuable as the forest wealth, it is believed, is its wealth in water powers. These are numerous, and chief among them is the famous Grand Falls on the Hamilton River, some 235 miles from tidewater, respecting which Professor A. P. Low, who explored the region for the Canadian Government in 1894 says, in a chapter contributed by him to Grenfell's "Labrador":

> The distance, between the lake expansion at the upper end of the portage route and the mouth of Bowdoin Canyon, is eight miles in a straight line running south-southeast. The river at the upper end of this line has an elevation of sixteen hundred and sixty feet above sea-level, a little below the general level of the surrounding country. Where it issues from the canyon into the main valley, it is nine hundred feet above the sea; there is thus a drop of seven hundred and sixty feet in a distance, by the river, of less than twelve miles. Considering the volume of the stream, estimated at fifty thousand cubic feet per second, this is a phenomenal descent. If the energy developed by the fall could be turned into work, it would produce the enormous amount of upwards of four million three hundred thousand horse-power. Neglecting the rapids above and below the falls and confining the calculation to the power of the falls itself, we find that it would develop energy equal to one million seven hundred thousand horse-power, an amount sufficient to operate a large proportion of all the manufactories and railways of Canada.[8]

On the river there are several other falls, notably the Muskrat Falls, less than thirty miles from tidewater and capable of developing in the present unregulated condition 500,000 horse power, with the possibility of doubling this production by proper regulation of the stream.

Numerous other rivers exist in the territory, all of which have extensive water-power possibilities that have not yet been measured or even considered.

What is true with regard to the timber possibilities of Labrador is equally true with respect of water-power possibilities. Nowadays the two are harnessed together, water power being the chief factor in the production of paper and being used for many other purposes besides, all of which tend to enhance the potential value of the hydroelectric energy in this region.

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[8] W. T. Grenfell: Labrador: The Country and the People, new edit., New York, 1922, pp. 151–152.

The mineral possibilities of the territory have not yet been seriously weighed. Professor Low is the authority for the statement[9] that west of the watershed beyond the Grand Falls there are enormous deposits of iron ore which are bound to be developed in the future. Some students of the problem think that in the smelting of these electric energy from the Grand Falls will probably be utilized, the resulting product being then shipped to tidewater by a railroad which will probably be built northward from Belle Isle Strait to a suitable point. Along the line of railway it is also suggested that a power transmission line will some time be constructed for the conveyance of electricity to tidewater whence it may be utilized in connection with industries established on the coast, or perhaps carried across to Newfoundland and put into service in connection with a variety of industries which the possession of this power will make it possible to inaugurate there.

Some idea of what the future of Labrador may be can be gained by a study of the case of Alaska, which occupies a somewhat similar position at the western end of North America that Labrador does at the eastern end. Alaska was purchased by the United States from Russia, in 1867, for $7,200,000; and when this was paid there was much outcry in America against the transaction because it was thought that the region would never be worth anything. In the past sixty years the production of gold, coal, and other minerals from Alaska, together with its fishery, forest, and other wealth has returned to the United States the amount of its investment a hundred and more times over. In the light of that example it is not unreasonable to suppose that something similar may occur with regard to Labrador.

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[9] A. P. Low: Report on Explorations in the Labrador Peninsula along the East Main, Koksoak, Hamilton, Manicuagan, and Portions of Other Rivers in 1892–93–94–95, *Ann. Rept. Geol. Survey of Canada for 1895*, Part L, p. 284.

GEOGRAPHY AT THE FIRST INTERNATIONAL CONGRESS OF SOIL SCIENCE

C. F. Marbut

Bureau of Soils, U. S. Department of Agriculture

THE First International Congress of Soil Science was held in Washington, D. C., from June 13 to June 22, 1927.[1] Its work included the reading and discussion of papers, the exhibition of scientific material, the formulation of recommendations regarding future work, and the excursions. Papers were presented in general sessions and in meetings of the several International Commissions by which the technical work of the International Society is performed.

PAPERS OF GENERAL INTEREST

Among papers read at the general sessions one by Dr. Albrecht Penck, discussing the probable ultimate capacity of the earth for supporting population, has a special geographical interest. Dr. Penck, who has given the subject a great deal of attention, has already published his views thereon.[2] The fundamental basis of his estimate of the possible capacity of the earth is climatic. He gives the tropics, Brazil for instance, an extremely high rating. He assigns only 14 per cent of the total ultimate world population to the North American continent and about 26 per cent to South America. Penck realizes that the soil factor has been almost wholly neglected in his estimate and for that reason places special emphasis on the importance of preparing and publishing a soil map of the world. This was suggested to him in part by the action of the General Committee of the International Society of Soil Science, in agreeing unanimously to direct its attention at once to the preparation of such a map. The governments of all countries will be urged to inaugurate without delay the work of preparing soil maps of their respective areas. Funds will be sought from private sources also, and effort will be made to have exploring and other scientific expeditions, organized in the future, include well trained soil specialists in their scientific staff.

Another important paper was Dr. O. E. Baker's excellent interpretation of present-day trends in American agriculture based on the data of the 1925 agricultural census of the United States. This will soon be published as a bulletin of the United States Department of Agriculture.

The Presidential address by Dr. J. G. Lipman, "Soils and Man," also had considerable geographic value. It consisted of a brief summary of the salient facts of the agricultural history of Western Europe and America interpreted in terms of soil productivity and the increasing knowledge of and skill in handling the soil.

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[1] Four meetings of soil specialists, international in their scope, had taken place previously. The first was held at Budapest, Hungary, in 1908 and was designated as an Agrogeological Conference. A second was held in Stockholm in 1910, while the third was to take place in Russia in 1913, but conditions arose previous to the time of meeting which made it necessary to postpone it. No meeting was held during the war. In the spring of 1922 a number of specialists who had taken part in the Budapest and Stockholm meetings organized a Third Conference which met in Prague, Czechoslovakia, in April of that year. At the invitation of the Italian Government and the International Institute of Agriculture at Rome it was agreed to hold the Fourth Conference in Rome in May, 1924. At this meeting an International Society of Soil Science was organized as a permanent body under whose auspices future meetings of soil specialists should take place. The first meeting to take place under the new organization was the First International Congress of Soil Science at Washington in June, 1927.

[2] Albrecht Penck: Das Hauptproblem der physischen Anthropogeographie, *Sitzungsber. Preuss. Akad. der Wiss., Phys.-math. Klasse,* Vol. 22, 1924, pp. 242–257; also published in *Zeitschr. für Geopolitik,* Vol. 2, 1925, pp. 330–348.

One afternoon and an evening session of the Congress as a whole were devoted to the presentation, by the Russian delegation, of the results of Russian work in soil investigation. These results were summarized in a series of brochures in English, prepared in attractive form and presented to the members of the Congress. This constitutes the first complete statement in English of Russian accomplishments in this field, except the book published in German by Glinka more than ten years ago and now for the first time available in English.[3]

The Soil Commissions

The Commissions, six in number, deal respectively with (1) Physics of Soils; (2) Chemistry of Soils; (3) Biology and Biochemistry of Soils; (4) Fertility of Soils; (5) Classification, Nomenclature, and Mapping of Soils; (6) Management and Technology of Soils.

The work in most of them was predominantly technical rather than geographic. This may seem at first glance necessarily so, but more careful consideration suggests that each may in time trend strongly in a geographic direction. In fact, from one point of view one would seem justified in designating the part of their work that does not have a definite geographical relationship as preliminary and immature. The study of the physics of soils, for instance, cannot be carried out without the study of some particular soil or soils each of which not only has a definite distribution over the earth's surface but has a definite and intimate relationship to those forces prevailing on the earth's surface which determine the character and distribution of organic life including that of man.

This stage in the work of most of the Commissions has not yet been reached, at least in the United States and western Europe. It has been reached in Russia, and the accumulation of results has begun. It is expected that the western world will learn a great deal about them when the next International Congress of Soil Science meets in Leningrad in 1930.

Classification, Nomenclature, and Mapping

The Fifth Commission, on Classification, Nomenclature, and Mapping of Soils, dealt with soils from a geographic point of view to a much greater extent than did any of the others. This is especially true in its treatment of soil cartography and also in classification, since in the latter term is included not merely the assignment of soils to certain "pigeonholes" in a scheme of arrangement but also the creation of soil units or groups through the determination, evaluation, and comparison of their characteristics and the working out of soil genesis in terms of environmental relationships.

At the Rome Conference in 1924 it had been agreed that the pedologists of the Conference would concern themselves up to the time of the Washington meeting in 1927 with the accumulation of actual soil knowledge expressed in terms of the soil profile features in order that an attempt might be made to classify the soils of the world on the basis of soil features rather than on that of climate, geology, crops, natural vegetation, or any other basis not residing in the soil itself.

The response was very gratifying. Data, in large quantity, were presented, both in the form of descriptive material and as colored charts, the latter from Norway, Russia, Rumania, Hungary, Latvia, and the United States being especially abundant and significant. Nearly all of this material was presented to the Bureau of Soils and will be used as the nucleus of a great soils exhibit as soon as a permanent place can be found in which to install it. It is now in storage in Washington. The material presented by Russia alone is greater in quantity and more significant in quality than that of all the other countries combined.

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[3] D. K. Glinka: The Great Soil Groups of the World and Their Production, Edwards Brothers, Ann Arbor, Mich., 1927.

A paper by Professor Polynov was especially important from the geographical point of view. He showed that the soil to a greater extent than any of the other features or bodies occupying the earth's surface, even including animals, expresses in its features the combined effect of all the forces of the geographic environment.

Two sub-commissions to the Fifth Commission were concerned with the preparation of soil maps of Europe and the Americas respectively. The European subcommission headed by Dr. Hermann Stremme of Danzig prepared and presented to the Congress the first soil map of Europe in which the great soil groups of the Continent, differentiated on the basis of broad soil characteristics, were shown. The map, accompanied by a brief descriptive text, has been published by the Prussian Geological Survey, through the efforts of Dr. W. Wolff, the secretary of the subcommission. In addition, a revised soil map of European Russia, brought up to date by Professor Prassolov, constituted a part of the Russian exhibit. It will be published shortly. A recently prepared soil map of Poland, differentiated in considerable detail, was presented by Dr. Michlaschewski. It has been published by the Government of Poland. Professor Treitz presented maps of Hungary; Professor Saidel, of Rumania; and maps of Esthonia and Latvia were sent for exhibition.

No attempt was made by the sub-commission on the soil map of the Americas to present a soil map of either of the continents. The data available for Mexico, Central America, and South America are as yet wholly inadequate for an attempt at even a generalized soil map. A small and very much generalized but highly significant map of Chile was presented by Dr. Matthei and a soils map of Cuba by H. H. Bennett of the Bureau of Soils, but for none of the other Hispanic American countries was a soil map attempted.

The recently prepared and yet unpublished soil map of the United States on the scale of 40 miles to the inch was presented as the most important of the results accomplished in the mapping of the Americas. It will shortly appear as the Soils Section of the Atlas of American Agriculture. Generalized soil maps of two important Prairie Provinces, Alberta and Saskatchewan, Canada, by Professors Wyatt and Joel, were presented in manuscript.

THE EXCURSIONS

The excursions, local and transcontinental, formed a very important part of the congress. They will undoubtedly result in work of greater geographic value than any of the other general divisions of the congress. They were concerned entirely with the distribution over the American continent of soil characteristics and the relationship of these to the other factors of man's geographic environment. They assume especial significance because of the fact that on the North American continent there seems to be a wider range of varying geographic forces producing a correspondingly wide range of soil characteristics than can be found on any other.

A number of the most important soil groups of the North American continent are not represented at all in Europe or, if so, occur in such small area and in such imperfect development that they have received little attention. Furthermore, several of the groups developed in eastern Europe exhibit a much wider range of variations in this country. This is especially true of the groups of Steppe, or, as we call them in this country, Great Plains, soils. In Europe these soils occur in a series of east-west belts succeeding each other from north to south. They are the product of climatic forces, the two effective factors of which, rainfall and temperature, both change from north to south, the rainfall decreasing and the temperature increasing. In the North American continent, however, one of these factors changes from east to west, the other from north to south. Instead therefore of a series of parallel belts differing in accordance with the combined effect of these two factors we have a checkerboard arrangement of areas and therefore a much greater number of condition variations. Our soil belts become soil areas approximately rectangular. There are a great number of soil units, and we have also presented to us an opportunity to determine the effect on the soil of increase or decrease of moisture without change of temperature or, vice versa, of increase or decrease of temperature without change of moisture.

Not only has the crosswise distribution of the two great climatic factors in soil development produced in this country a great number of sub-varieties of the well known soil belts, as developed in Europe, but other factors in soil evolution, not fully functioning in Europe, have produced soil groups not known at all, or in imperfect development only, in Europe. Four such groups of soils are (1) brown forest soils; (2) red forest soils; (3) yellow forest soils, and (4) prairie soils.

Four Soil Groups of Particular Interest

The brown forest soils are similar to the brown soils named by Ramann but not described in detail by him. It is apparent, however, that because of the moist climate in central western Europe the occurrence of soils of this general character with fully developed, or what we in the United States call mature, characteristics is there very limited. The dryness of the forested regions of the United States where these soils are developed as compared with that of Europe was a constant cause of surprise to our European visitors. These soils were examined in typical localities in two full-day excursions in Maryland and Virginia during Congress week and in Missouri and Indiana during the transcontinental excursion.

The two great groups of red soils of the southern states were both visited. Those developed from limestones, seen in the Knoxville region, being essentially identical with those of southern Europe, presented no new problems, though notable for their wide range in variations, the definite expression of relationship one to another, and to their environment. The red soils of the Piedmont region, the prodigality with which they display their color richness, and their wide extent and relationships received the maximum of attention during the first few days of the transcontinental excursion. Such soils are almost unknown in Europe, those on certain small areas in the Caucasus region approaching them in character. Interest in them centered around the question of the period during which their striking characteristics were developed. Glinka has expressed the opinion, seemingly not entirely concurred in by his colleagues, that they are not the product of the existing climatic environment but are ancient (fossil) soils developed under conditions different from those of the present day. This raised the highly important question of recent or relatively recent climatic change. The large area and the clearly expressed characteristics of such soils in the United States may be expected to supply some important data toward the solution of the question of climatic change. The same question is involved in the discussions aroused over the highly important group of prairie soils to which reference will be made below.

One of the important groups of soils in the United States, wholly without representation in Europe, unfortunately could not be visited, though their characteristics were described and an interpretation attempted in the Guide to the Excursion. A region comprising the southeastern part of Georgia, a small area in South Carolina, the southern part of Alabama, and all of Florida is covered with a group of soils which seemingly represent the northern extension of influences prevailing widely in the tropics and responsible for their highly characteristic soils. These soils are in a sense fossil but do not necessarily present evidence of a recent change of climate. The climate then as now seems to be identical in kind if not in degree of expression to that prevailing in the tropics. The fossil character is to be ascribed rather to topographic change and represents normal development rather than revolution. The same questions raised by these soils are raised by those of Cuba, recently studied by Bennett. They will constitute the subject of some new geographic literature in the near future.

The soils whose features provoked the liveliest discussions of all, and over the interpretation of which the widest differences of opinion prevailed, are those of the American prairies, or the humid grassland soils. The fact that they are practically unique among the soils of the world, as well as their very great economic importance, added interest to the discussions. The point on which the widest difference of opinion prevailed was their assignment by the Russians to the degraded *chernozems*.

In Russia the forests are spreading southward over country that until recently was grassland and was covered by soils with well defined *chernozem* characteristics, such as dark color, highly developed granular structure, and zone of carbonate accumulation—features defined by them as those developed only under the influence of low rainfall (about 20 inches in mid-Russia) and a grass vegetation.

Where forests have invaded such a region the soils gradually lose their dark color and their granular structure. However, in no place in the literature is a soil identified as degraded *chernozem* in which the zone of carbonate accumulation is not still intact, although our unfamiliarity with the Russian language in this country may have led us into an error regarding this point. In none also is a soil now lying in a region of 30 inches or more of rainfall identified as degraded *chernozem.*

When the true normally developed prairie soils were first seen near Kansas City they were immediately identified by the Russians as degraded *chernozem* regardless of the fact that they lie in a region where the rainfall is now as high as 35 inches, and in which there seems not only to be no trace whatever of a zone of carbonate accumulation, but where the parent rock carbonate has been removed to a depth of many feet. Such identification demands that the soils were originally developed under a rainfall of not more than about 25 inches, probably less, that after development they were invaded by forests, due to change of climate from dry to wet, were degraded, and still later were subjected to conditions—climatic or otherwise—which caused the disappearance of the forest cover.

The Americans among the excursionists found themselves wholly unable to agree with this interpretation in view of the complete absence up to date of correlative evidence of the necessary changes in climate. The Europeans themselves, after having considered all the factors so far as they are now known, frankly admitted that the case is a complicated one and requires much research.

Another region regarding which considerable difference of opinion manifested itself is that in the vicinity of Edmonton, Alberta. According to the American interpretation the predominant soil in this region consists merely of one of the several if not of the many varieties of the soils of the *Chernozem* belt, a variety whose divergence from true *chernozem* is due to short summers, relatively low temperatures, and early summer rainfall. By many of the Europeans, however, it was identified as a member of the *Wiesenboden* group, a group of soils imperfect in their development on account of an excess of moisture. That the moisture is superficial, however, and does not affect the whole soil profile is shown by the presence in them of a well developed zone of carbonate accumulation.

GEOGRAPHICAL RECORD

NORTH AMERICA

Lake Melville: True Lake or Inlet of the Sea? The evidence presented by the Colony of Newfoundland and the Dominion of Canada in their recently settled boundary dispute constitutes almost a library on Labrador in itself, filling eight substantial volumes. The geographical documents include extracts from most of the published works on the country, as, for instance, those of Dr. A. P. Low and Dr. (now Sir) Wilfred Grenfell; and special mention may be made of an excellently illustrated section by R. A. Daly on the "Topography of the Northeast Coast of Labrador." Probably the most interesting point geographically is the argument over Lake Melville (see the map, Fig. 4, p. 657). In the event of the Dominion establishing its main contention Newfoundland had intended to claim that the littoral strip should be carried round the head of the Lake—150 miles from the outer coast. Fortunately for the Colony, this issue did not arise.

The best description of Lake Melville available is E. M. Kindle's "Geography and Geology of Lake Melville District, Labrador Peninsula" (*Canada Geol. Survey Memoir 141*, 1924), extracts from which are among the chief Canadian evidence. The lake is fiord-like, with a maximum depth of 160 fathoms; steep scarps rise to 2000 feet on the south; the northern scarp is less steep and more irregular. To the west the lake is bordered by a terraced plain. In sum, says Kindle, the main physiographic features "are in their essentials the products of subaerial and river erosion modified by glaciation and directed in some degree by important structural features." The shallow outlet of the Narrows, 9 to 30 fathoms deep, represents a postglacial channel, the preglacial Hamilton reaching the sea by the Backway channel. Hamilton Inlet is relatively shallow and is classed by Kindle as a ria.

Professor J. W. Gregory, on the other side and supported by Professor Schuchert, emphasizes the "essential unity" of the three bodies of water, Lake Melville, Narrows, and Hamilton Inlet; he discusses the general physiography of the coast and explains Lake Melville as a fiord, due to faulting. Professor Douglas Johnson disagrees with this interpretation of the lake and, furthermore, maintains that the fiord question is not relevant here. He suggests that light may be shed on the problem by imagining the effect of a considerable drop in sea level—say 1500 feet. Lake Melville would still retain its essential conformation as a characteristic expansion of the river, whereas Hamilton Inlet would disappear, being replaced by a river channel. Parenthetically, reference may be made here to the characteristically clear discussion of coast terminology included in Professor Johnson's evidence.

Navigability by ocean-going vessels, a considerable degree of salinity, and the tides of Lake Melville are brought forward by Newfoundland as evidence in favor of its maritime character. On the other hand W. J. Stewart, chief hydrographer of Canada, points to the ebb tide of greater flow and longer duration and the retardation of the tidal wave as characteristic of river tides, with which view G. W. Littlehales of the U. S. Hydrographic Office does not agree. W. Bell Dawson, superintendent of the Tidal and Current Survey of Canada considers Ticoralak Point, a few miles below the Narrows, as the "crucial" point representing the head of the estuary, for here the tide is at its maximum. Leveling operations carried out by Canada were not conclusive.

As regards salinity of the waters, Kindle gives as his opinion that a pronounced change marking the westward limit of truly maritime conditions occurs at Indian Harbour in Hamilton Inlet. C. Tate Regan, formerly of the British Museum, considers Kindle's investigation incomplete and states that his selected maritime species are found elsewhere in waters of as low or lower salinity. M. L. Fernald also questions certain identifications and statements as to habitat, citing maritime plants found at the head of Lake Melville which elsewhere are confined to sea margins. Johan Hjört, consulted on the practical issue of the cod fishery, does not believe that the waters of Lake Melville are suitable for the sea cod; he points out that the Baltic cod is not a pelagic species. According to Grenfell it is safe to say that few cod enter Lake Melville. Salinity observations on the lake were made by the Canadians, but the depth observations are incomplete.

It is impossible to indicate here the great range and interest of the arguments; the above instances will serve to illustrate the complexity of the problem.

Newly Discovered Falls in the Hamilton Basin of Labrador. The glaciated plateau of Labrador and its myriad lakes "that occupy at a moderate estimate at least one-quarter of the total area" (Low) present a drainage tangle still awaiting solution. A correction and addition to Low's pioneer work in the Hamilton River drainage basin has lately been given by Mr. Varick Frissell (Explorations in the Grand Falls Region of Labrador, *Geogr. Journ.*, Vol. 69, 1927, pp. 332–340). In July, 1925, Mr. Frissell, accompanied by Mr. James Hellier, undertook an expedition to the Grand Falls region, aptly described as the "key to the development of the entire Peninsula" (compare Sir Patrick McGrath's paper in this number of the *Review;* and see the map, Fig. 4, p. 657).

Some excellent pictures of the great falls were secured, and the party then proceeded southwest in search of the "unknown channel" reported by Low as entering the main stream some few miles below Bowdoin Canyon. They struck the stream about twelve miles above its mouth and proceeded up it on the left or north bank. A continuous series of rapids brought them to the rumored falls. The river was split in two by a high island. The northern branch again divided, the two arms uniting halfway down to fall to the bottom 120 feet below. A close view of the southern falls was obscured by mist. These latter seem to be the ones described in the July, 1925, number of the *Geographical Journal* (p. 79) as seen by Mr. J. G. Thomas and named by him Grenfell Falls. Mr. Frissell proposes the name Yale Falls for those on the northern branch and Grenfell for the name of the river.

Exhaustion of provisions and threatening forest fires prevented further exploration above the falls, but as far as the eye could see the river flowed tranquilly between low shores. Considering the volume of water carried, Mr. Frissell believes that it is the Grenfell River that carries off the waters of Lake Ossokmanuan. Certainly it is not the "Valley River" of Low. This was shown to be a fossil valley, an old main valley of the Hamilton before glacial diversion. The upper part of this old valley has been obliterated, its place being taken by two small brooks which were crossed near their source on the return journey to the Hamilton.

Natural Divisions of the Region of Chicago. The Chicago Regional Planning Association has under its survey an area of some fifty miles radius from the city of Chicago. This "Region of Chicago," as it is termed, includes 250 towns and villages in the states of Illinois, Indiana, and Wisconsin. The first requisite of a regional survey, the base map, has been made under the direction of Professor J. Paul Goode. It shows counties, townships, sections, the checkerboard of roads that so largely define the sections, railways, rivers, canals. To accompany the map Mr. F. M. Fryxell has prepared a description of the natural features of the region (The Physiography of the Region of Chicago, University of Chicago Press, Chicago, 1927). The volume includes the base map on the scale of 4 inches to the mile, maps in color, showing glaciology, relief, drainage, and soils on a scale not stated but slightly less than half that of the base map; and numerous text maps, diagrams, and excellent photographs.

The Region of Chicago is almost at the center of the physiographic province called by Professor Fenneman the Central Lowland. Within the region itself alternating ridges, plains, and valleys roughly paralleling Lake Michigan lead to a differentiation into six natural divisions. The Lake Plain is a great industrial area. Its remarkable smoothness offers many advantages to urban growth offset in part by the drainage and sanitation problems presented. From the Plain the Chicago Outlet leads to the Mississippi Valley, crossing the Continental Divide at an elevation of only 15 feet above Lake Michigan. This important pass is now occupied by parts of the Des Plaines and Illinois Rivers and is traversed by the Illinois and Michigan and Chicago Drainage Canals and by highways and two railways.

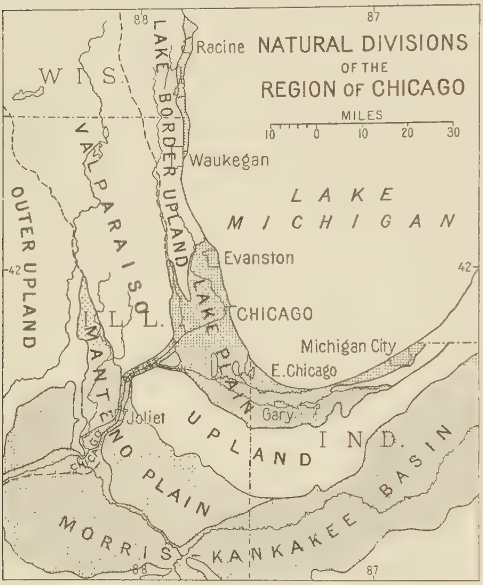

FIG. 1—Natural divisions of the Chicago Region from Figure 2 of Mr. Fryxell's work.

Three morainic belts, the Lake Border, the Valparaiso, and the Outer Uplands, separated to the south, coalescing in the north, comprise good farm and dairy land. Those parts near Chicago are being increasingly developed for residential and recreational purposes. In the Lake Border Upland residential towns are continuous to the Wisconsin line, commuters to Chicago being well served by steam and electric railways. Still primarily an agricultural region, the Valparaiso Upland has a predominance of small country towns, the larger ones on the main streams or on the margin of the Lake Plain. The northern part of this Upland exhibits a more rugged relief, up to 450 feet, a picturesque "knob and kettle" topography. The central portion and inner edge of the Upland are connected with Chicago by a close net of railways and are developing a suburban character. The Outer Upland is an agricultural area. Between the Valparaiso and the Outer Upland lie the Manteno Plain and the Morris-Kankakee Basin. The Basin is mostly sandy and formerly was largely covered with marsh. Where drained it constitutes agricultural land. Sections, however, remain in a primitive state—a paradise of wild life—and their preservation is urged. Conservation of the interesting and beautiful dune country at the head of Lake Michigan, described in a chapter on the lake and its shore, is also urged. Indiana is planning a Dunes Park that will embrace 2000 acres.

Mr. Fryxell concludes his study with a brief account of the geology and geological resources of the region. Its economic advantages derived from soils, topography, and situation have been described by Professor Goode in a preliminary regional analysis "The Geographic Background of Chicago" (Chicago University Press, Chicago, 1926).

The Southern California Rift Club. The Southern California Rift Club was informally organized in the spring of 1926, with the object of bringing together the various scattered observers of the many rifts and displacements of that much fractured region and with the hope of thus defining better than has yet been done the location of certain rifts, of determining the nature and the amount of the movement that has already taken place upon them, and of measuring any movement that may take place in the future. Several meetings of the club have been held, including an open meeting on Sunday, May 29, 1927, where more than a hundred members and friends gathered at Mountain View in the Narrows of Cajon Pass—that remarkable northwest-southeast depression by which the San Gabriel Range on the west is obliquely separated from the San Bernardino Range in the east. The Pass is familiar to many transcontinental travelers, inasmuch as the main line of the Santa Fe Railway and the Salt Lake-Los Angeles line of the Union Pacific make joint use of the tracks through it in the descent from the uplands of the Mohave Desert on the north of the mountains to the orange-grove lowlands on the south; but it is probable that few of those travelers realize the altogether exceptional character of that part of their route.

The pass appears to be largely due to the erosional excavation of great slabs, several miles in length, of relatively weak sandstones which have there been downfaulted between the much more resistant crystalline rocks of the mountain ranges; and as such it is certainly one of the most remarkable structural and physiographic features of the great Southwest. It is followed, but in a still more oblique, west-southwest to east-southeast course, by the famous San Andreas rift belt, on which the earthquake of 1906 was caused by a 15- or 20-foot, horizontal shift of the earth crust northwestward on the southwest side of the rift with respect to the northeast side in the San Francisco region. Whether the downfaulting of the weak sandstone slabs is due to early displacements on the San Andreas rift belt is not yet determined; but there seems to be a rather close association of the early and later movements in a single belt of compound, communicated fractures.

The president of the Rift Club, Dr. Levi F. Noble, opened the meeting and introduced Prof. J. B. Buwalda of the California Institute of Technology at Pasadena, who gave a general account of the San Andreas rift belt in the region of the Pass, emphasizing the numerous sub-parallel faults which it includes and describing the various geologic and topographic features by which it may be traced. He also explained that, in consequence of the complex displacements along the rift belt, which has a width of a mile or more, many great slices and slabs of rock, more or less crushed by the friction and pressure to which they have been subjected, are now found in discordant relation to one another and to the country rock on either side of the belt. The great length of the rift belt was also noted: it has been traced from the Pacific coast, north of San Francisco, through middle and southern California, and probably into Mexico: it should therefore be ranked among the major lineaments of the earth's crust.

Professor W. M. Davis of Harvard University next spoke, with especial regard to the contrast between rifts of the San Andreas type, on which movements with a large horizontal component seem to predominate, and rifts of the Wasatch type, on which movements with a large vertical component prevail. In examples of the first type the path or trace of the rift is nearly rectilinear, and there is no strong or persistent difference of elevation on its two sides. In examples of the second type the trace of the rift departs from a straight line in many concave bights from one to five or ten miles in curved length, between somewhat pronounced cusps which point from the side of elevation to the side of depression; and the side of elevation is occupied by a more or less dissected mountain range, while the side of depression is occupied by an aggraded plain of mountain-supplied detritus. Professor Davis also called attention to the importance of establishing monuments on the two sides of various rifts at selected points in order that future movements shall be detected.

Later Dr. Noble led the party up the near-by mountain slope on the northeastern side of the Pass over the Narrows, whence the direct course of the oblique rift belt was pointed out for a number of miles along the flanks of the mountains, to the west-northwest on the northern side of the San Gabriel Range and the east-southeast on the southern side of the San Bernardino Range. Attention was also given in some detail to the occurrence of several great rock slabs of diverse composition and of large displacement in the rift belt, which Dr. Noble has recently been investigating for the U. S. Geological Survey. Many small movements on the rifts of recent date seem to have been the successors of greater, long continued earlier movements.

It was thus made clear that, if the excavation of the Cajon Pass is due to the erosion of the slabs of relatively weak sandstones which occur there, the downfaulting of those slabs must be of much earlier date than the recent movements on the rift belt, some of which are as yet little modified by erosion; but, even so, the earlier movements cannot be geologically ancient, because the downfaulted sandstone slabs are of relatively modern (mid-Tertiary) formation.

W. M. Davis

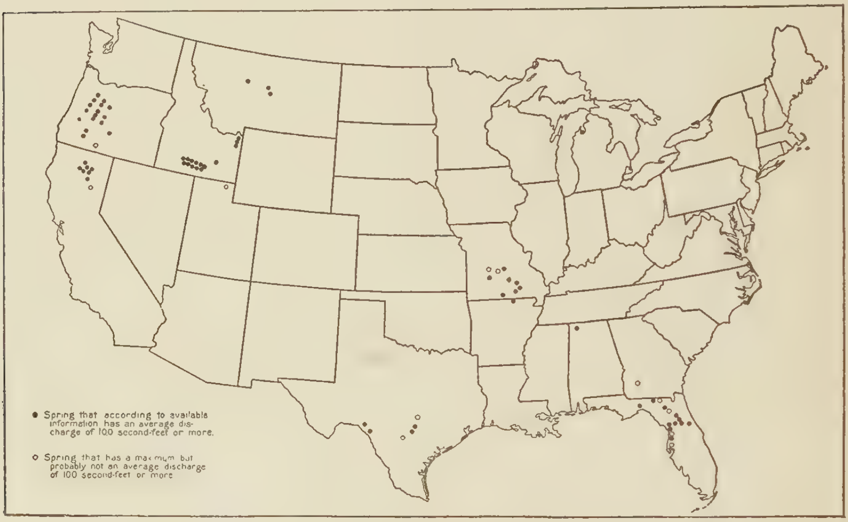
● Spring that according to available information has an average discharge of 100 second-feet or more.
○ Spring that has a maximum but probably not an average discharge of 100 second-feet or more

Fig. 1—Map of the United States showing the distribution of large springs. Reproduced on a reduced scale (about 1: 45,000,000) from Figure 1 of *Water-Supply Paper 557*.

Large Springs in the United States. Each region in the United States has its own favorite "Big Spring," but the information as to what constitutes a large spring and where they are to be found has hitherto been scattered. This gap has been conveniently filled by O. E. Meinzer's "Large Springs in the United States" (*U. S. Geol. Survey Water-Supply Paper 557*, 1927).

The basis of classification of the size of a spring is according to its discharge and is measured in second-feet (1 second-foot equals 1 cubic foot of water discharged a second, or 448 gallons a minute). Springs are considered to be of first magnitude when their discharge is 100 second-feet or more. According to available data there are 65 such springs in the United States.

In general the water discharged by these springs is meteoric water that has not reached depths of more than a few hundred feet below the surface. The result is that with few exceptions the temperatures of the large springs are not much above the mean air temperatures of the region in which they occur.

The large springs of the United States are scattered throughout the country from Florida to California, but those of first magnitude occur in relatively few regions (as shown on the accompanying map). The largest springs are usually found in limestone regions containing well worn solution channels, the work of ground water, or in areas of jointed and broken volcanic rock. Only in rare instances are they found in gravel where water is more easily dispersed and not concentrated in one area.

A group of very large springs is found in northern and central Florida and adjoining parts of Georgia and Alabama, occurring in soft Tertiary limestone. This region is usually accredited with having the largest limestone springs in the United States, but at the present time measurements are too incomplete to substantiate this statement. Silver Springs, the largest of these, emptying into a basin about an acre in size and fully 35 feet deep, gives rise to a navigable stream. Measurements of the discharge range from 342 to 822 second-feet.

In the Ozark region of Missouri and Arkansas, chiefly in dolomitic rocks, seven springs with discharges ranging from 100 to several hundred second-feet have been recorded.

Two varieties are found in Texas, artesian springs occurring at the edge of the Coastal Plain in the fault zone and gravity springs in the Edwards Plateau where stream valleys have cut down to the water table.

In the drainage basin of the Snake River, Idaho, are a number of large and spectacular springs. Eleven of the first magnitude occur in a stretch of 40 miles along the Snake River below the Shoshone Falls. Of these, one (Malade) yields more than 1000 second-feet; three, from 500 to 1000 second-feet; and seven, from 100 to 500 second-feet. Most of the springs issue at such a height above the river that the potential power resources are very great. Power plants have already been installed at Malade, Thousand, and Sand Springs. It is interesting to note in connection with these figures that in 1925 New York City's daily consumption of water was about 800,000,000 gallons a day, or approximately 1238 second-feet, an amount that could almost be supplied by one of these springs alone.

The great area of basaltic rock containing the Idaho springs extends into northern Nevada, northeastern California, over most of Oregon, and over a large part of Washington. Springs rivaling those of Idaho are found here particularly in California and Oregon (Klamath River basin, west slope of Cascade Mountains in Oregon, and in the interior basin of Oregon).

Montana's springs rank among the very largest in the United States. The largest of these is Giant Springs, discovered in 1804 by Meriwether Lewis. It issues from a sandstone formation and discharges about 600 second-feet.

In spite of the magnitude of these springs the United States can lay no claim to the largest springs in the world. Measurements of the famous Fontaine de Vaucluse, which issues from a limestone formation, have given a maximum discharge of 5300 second-feet. This greatly exceeds any measurements in the United States. The average discharge is 800 second-feet; and this, too, is greater than that of any known limestone spring in the United States.

EUROPE

Three Recent Books on the Alps and Mountaineering. Most books and periodicals written by or for mountaineers are of interest to them alone—and more especially to those who have local knowledge of the various mountains concerned. Occasionally, however, there appear mountaineering publications of broader significance. These may be of two types: (1) studies of the history or philosophy of mountaineering in the large as distinguished from the records of particular climbs or the discussion of technical problems, and (2) interpretations for the climber or mountain lover of the geography of highland districts.

Alfred Steinitzer's "Die Alpinismus in Bildern," (Munich, 1924), a pictorial history of the Alps and "Alpinism" from the Middle Ages to the present time, is of the first type. Reproductions of the early woodcuts and prints of Alpine scenes and adventures—including a striking sketch by Leonardo de Vinci of a thunderstorm in the mountains—are followed by a remarkable collection of photographs of mountain landscapes and climbers in action. Numerous facsimiles of drawings, paintings, posters, and bookplates are given; nor is the humorous caricature or grotesque cartoon neglected. These, together with views of military operations (particularly in the Italian Alps during the World War), airplane photographs, illustrations of mountaineering on skis, of Alpine roads, camps, refuges, cabins, funicular railways, etc., provide a graphic record not only of the growth of mountain climbing as a sport but of the improvement in the artistic technique of representing mountains.

Two recent books of the second type deserve mention. The first, "Entstehen und Vergehen der Alpen: Eine allgemeinverständliche Einführung besonders für Bergsteiger und Freunde der Alpen," by Dr. Wilfried von Seidlitz (Stuttgart, 1926), is an interpretation of the geology of the Alps written in simple language for all visitors to the mountains, but especially for the climber. Thus, a special section is devoted to varying kinds of rocks as related to climbing, some knowledge of which is of the foremost practical importance to the mountaineer. The book is divided into three main parts which deal respectively with rocks, mountain structure, and features produced by erosion. The second part gives a clear explanation of the complex folded and overthrust strata of parts of the Alps.

In a wonderfully illustrated volume entitled "Il Monte Bianco" (Turin, 1926) Professor Giotto Dainelli, whose studies in the Himalaya were discussed in the *Geographical Review* (Vol. 17, 1927, pp. 138–142) deals with Mont Blanc and its immediate neighborhood on the Italian side. While the book is avowedly popular, written in a most engaging manner, it presents, nevertheless, the observations and reflections of a profound student both of physical and of human geography. Dainelli, also a great lover of mountain grandeur and of the sport of climbing, devotes several chapters to adventures among the high snows. But no less interesting to him are the people who dwell among the valleys and glens under the eastern face of Mont Blanc and the manner in which their environment is reflected in the circumstances of their daily life.

A visitor on arriving for the first time at Courmayeur sees so many buildings in the valley and scattered over the mountain sides that he gains an exaggerated impression of the density of population. Besides a dwelling house and hay barn in the village, each family is likely to have a châlet on the valley floor or mid-mountain slopes; and on the high "alps," or pastures, most of which belong to the communes, herdsmen's cabins and cattle stalls are found. The annual migration of the cattle up the slopes thus demands a quantity of buildings in relation to the population that would be altogether disproportionate elsewhere.

Families in this part of the Italian Alps are small, averaging between three and four persons, whereas in the rest of the country the average runs as high as five. Elsewhere in Italy the general rule holds that the more work done the more the land will produce, and large families are advantageous. In the mountains the agricultural ground is strictly limited both in area and productivity and can be made to yield no more than a given amount, no matter how much labor may be expended upon it. Here, therefore, large families only mean idle hands. Difficulties of communication also cause each village to live by itself and have little economic or social exchange with neighboring villages or the outside world. The native stock, consequently, has become inbred and, as is usually the case in mountain regions, has become somewhat sterile.

Isolation leads to extraordinary local pride and jealousy, which shows itself in the attitude of the mountain folk towards outsiders. "According to their psychology the world seems to be divided into two parts: on the one hand, Courmayeur and its vicinity, including Mont Blanc, and, on the other, the whole remaining part of Europe and the other continents; in the former dwell the few elect, whereas the latter are all *gardins*" (a term of contempt applied to outsiders).

ASIA

The Autonomous Soviet Socialist Republic of Tadjikistan. The little state which takes its name from the descendants of the once powerful Iranian people of Central Asia contains only a few of their scattered mountain-dwelling fragments, but its boundaries have been so adjusted that Tadjiks compose about 65 per cent of its population. It was created in 1924, in a subordinate relationship to the Uzbek Republic, out of the eastern portion of Bukhara, the southern part of the Samarkand Province, and the Pamir Plateau. Its area is about 135,000 square kilometers, roughly that of Czechoslovakia, which it also resembles in its irregular, elongated shape. In population and wealth, however, there is no comparison. According to various uncertain statistical computations, the population of the area in 1917 was about one million, which, in 1924, had been reduced by the casualties of civil war and by emigration into Afghanistan to about 700,000. This scanty population, with its meager resources of primitive village and nomad economic organization depleted by years of guerrilla fighting, is unable to support its own political administration, and some three-fourths of its governmental expenses have had to be covered by subsidies from the Uzbek Republic. The collection of articles, under the title "Tadjikistan" (N. L. Korzhenevski, edit.; maps and charts; Tashkent, 1925) upon which this sketch is based, were procured and published by the subsidized Society for the Study of Tadjikistan and the Iranian Peoples beyond its Borders.

It cannot be said that the survey of the country's resources and possibilities presented by these articles indicates any great prospects of development. Although the state lies in the latitudes of the mid-Mediterranean, and although some of its lower valleys at an altitude of over 400 meters afford subtropical conditions of life and support populations attaining a density of 109 per square kilometer, these districts are extremely restricted; while nearly half the total area, that composed by the Pamir Plateau, has an elevation of over 2000 meters and supports less than one person per square kilometer. The greater part of the rest is sufficiently elevated to share in the climatic and other conditions of high mountainous regions.

Mineral resources, the only possible wealth of such country, are not known to be more than mediocre. Gold is found in most of the river beds and terraces but in quantities sufficient to support only small-scale operations, having been washed out from low-grade deposits such as the Tertiary conglomerate of the northwestern Darvaz highlands; gold-bearing quartz has been discovered only in the valley of one of the tributaries of the Muk-su River. Several other minerals are present but are not known to be plentiful enough to warrant more than local exploitation such as in the primitive iron works of the Vanch valley in the middle of the country, where the smelting is done with charcoal. Coal beds of considerable extent and good quality exist in the Zarafshan basin, in the northwestern corner of the state, but are accompanied by no iron fields of any value.

The extraordinary difficulty of communication and transport, in a country of high mountain ranges and swift rivers, stands in the way of any coördination of its natural resources to produce a large-scale industrial development and restricts the exportation of raw materials. No railways penetrate the state, and none appear practicable beyond a couple of branch lines to connect the western valleys with the central Asiatic system. Even wagon roads are few and bad, but some development is possible in this respect. The only waterways navigable by steamboats are the Pyandj and Amu-Darya Rivers, which form the southern boundary, and one tributary, the Vakhsh.

Besides minerals, the principal commodities available for exportation are forest products, cattle, and hides. Forest culture presents great possibilities of development in the western half of the country. The lower and middle mountain slopes are adapted particularly to pistachio, walnut, and cedar growths. The full utilization of these potential resources, however, calls not only for improved transportation facilities but also for scientific reforestation and conservation owing to their serious depletion in the later nineteenth century by uncontrolled exploitation. A large proportion of the middle mountainous zone (1500 to 2500 m.), which constitutes the greater part of the area of Tadjikistan, is suitable for pasturage; and cattle raising and dairying constitute the principal resource of such regions. In the western vilayets, however, this resource, like that of lumbering, is in need of conservation, since the removal of trees has resulted also in much washing away and denudation of the grass-grown slopes, diminishing the grazing areas. The insecure conditions of revolutionary years, unfavorable to the wandering occupation of sheep herding, led to a general concentration on dairy and beef cattle. The supply of horned cattle was diminished in this period but not in such serious proportions (7 per cent) as the population (30 per cent) and other live stock (e. g. sheep, 40 per cent), losses being made up by the herds driven into mountain refuges from Turkestan. The most immediate hope for the establishment of a flow of exports to offset the needed imports of manufactured articles lies in cattle.

In agriculture Tadjikistan can be little more than self-supporting, although it is capable, despite the scarcity of arable land, of maintaining more than its pre-war population. The soil, of the nature of loess, is sufficiently fertile, and the climate is not too severe to permit the raising of grain crops even in the valleys of western Gorni Badakhshan. Rainfall is inadequate, however, at these high altitudes; and irrigation of the fields is required. In the valleys of medium elevation rainfall is sufficiently plentiful and well enough distributed through the year to permit dependence upon it for most of the grain production, but irrigation is also extensively resorted to. In the lowest-lying valleys rice and cotton are grown, the latter in quantities permitting a respectable exportation.

The recent conditions of disorder brought about not only a reduction of the cultivated area but also a shift in agricultural conditions generally. Deprived of freedom of movement by insecurity and with trade largely cut off, the people concentrated in the irrigated lands, abandoning over half their rain-watered fields, and devoted themselves to more intensive cultivation of a variety of crops, in order to supply as many needs locally as possible. This change, together with the analogous shift in the proportions of live stock, indicates a movement toward a higher level of economic organization. For continued advancement, however, reform is needed in the methods of agriculture, which has been of a primitive, extensive type, resulting in soil robbery and the degeneration of irrigated areas into swamps through lack of proper water control.

All the possibilities of development of this "national home of the Tadjik people" and farthest outpost toward India of the Union of Soviet Socialist Republics lie in a somewhat problematical future. The society which has published the studies mentioned above is engaged in research into the conditions and needs of the country and its people. Another of its publications is a translation from the Persian of "Kataghan and Badakhshan," by Burkhan-ud-Din-khan-i-Kushkeki (Tashkent, 1926), which contains detailed local topographic, economic, demographic, and historical studies (completed in 1923, with numerous maps) of the Pamir region and the northern portions of Afghanistan.

J. V. Fuller

Railroad Development and Immigration in Manchuria. Manchuria of recent years has enjoyed a prosperity "unmatchable elsewhere in China." Some measure of this progress appears in papers by Mr. C. Walter Young in the *Chinese Economic Journal:* "Economic Bases for New Railways in Manchuria" (April, 1927) and "Chinese Labor Migration to Manchuria" (July, 1927). This frontier country has entered on the stage of transformation "from extensive to intensive agriculture, from hand to machine manufacture, from cart to car transportation." Already

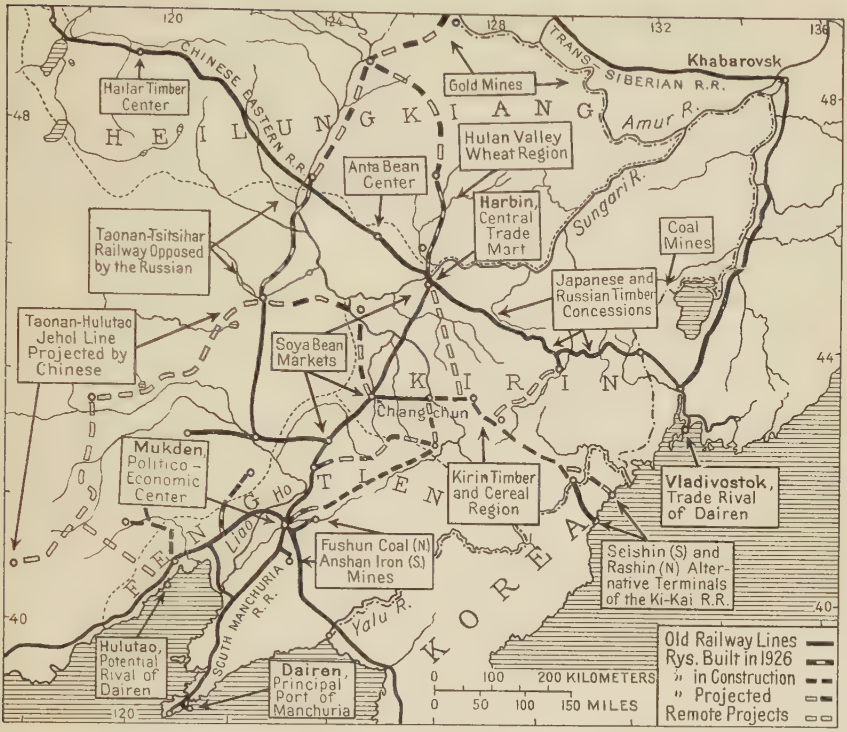
120
124
128
132
136
48
44
40
Khabarovsk
TRANS-SIBERIAN R.R.
Gold Mines
Amur R.
Hailar Timber Center
HEILUNGKIANG
CHINESE EASTERN R.R.
Hulan Valley Wheat Region
Anta Bean Center
Harbin, Central Trade Mart
Sungari R.
Coal Mines
Taonan-Tsitsihar Railway Opposed by the Russian
Japanese and Russian Timber Concessions
Taonan-Hulutao Jehol Line Projected by Chinese
Soya Bean Markets
KIRIN
Changchun
Mukden, Politico-Economic Center
FENGTIEN
Liao Ho
Kirin Timber and Cereal Region
Vladivostok, Trade Rival of Dairen
Fushun Coal (N) Anshan Iron (S) Mines
Seishin (S) and Rashin (N) Alternative Terminals of the Ki-Kai R.R.
SOUTH MANCHURIA R.R.
Yalu R.
KOREA
Hulutao, Potential Rival of Dairen
Dairen, Principal Port of Manchuria
0 100 200 KILOMETERS
0 50 100 150 MILES
Old Railway Lines
Rys. Built in 1926
" in Construction
" Projected
Remote Projects

FIG. 1—Map redrawn from Mr. Young's "Map Showing the Economic Bases of the Manchurian Railway System." Scale of map approximately 1: 13,000,000.

Manchuria has more than half the railroad mileage of the rest of China—nearly 3000 miles where 30 years ago was not a rail. Some 600 miles are under construction, and projects "reasonably" sure of maturing within the next pentad would bring the total to nearly 5000 miles. Among Chinese ports, Dairen now ranks second only to Shanghai as regards total trade. Tientsin, with greater import trade, is outdistanced by Dairen's exports to Japan. Dairen furnished about nine per cent of the Maritime Customs revenue in 1925, exceeded only by Shanghai and Tientsin.

The new railroad developments are of special interest in relation to the central and northern sections of the country. Southern Manchuria, best known and most populated, is usually thought of as having great agricultural value; but in soil fertility it is inferior to the regions about Changchun and Kirin in the center and Harbin and the Sungari and Amur valleys of the north. The greatest agricultural development of the near future will probably be in Kirin; but the greatest ultimate possibilities are in Heilungkiang, now having only 12 persons to the square mile where the country as a whole has 50.

The most striking phenomenon of the present moment in Manchuria is the great wave of migration from China proper. "There is probably nowhere in the world today a migration similar in size or parallel in point of bearing on a new area of colonization and industrial exploitation."

This northward movement is not new. Even before the establishment of the Manchu dynasty in 1644 Chinese farmers had settled in the fertile Liao valley, and subsequent stringent measures to keep them from transgressing the Great Wall failed. The opening to Chinese of lands in northern Manchuria in the middle years of the nineteenth century was followed by an influx that rapidly changed their ethnic complexion. According to the description of Abbe Huc the Chinese "burst like torrents upon Manchuria."

It is, however, since China became a Republic that the volume of immigration has increased so notably—sensationally so in the last two years. Before 1925 probably not more than 400,000 Chinese immigrated to Manchuria, and about 75 per cent of these were of the "spring come, autumn go" category. For the current immigration year, November 1926 to October 1927, it is estimated that the figure will be in the neighborhood of a million immigrants with less than half returning. The railroad development, the cheap and readily available lands, the demand of labor for the coal mines of Fushun, Penhsihu, and Yentai and for the industrial centers are responsible in some degree; but the prime cause is that in the present state of internecine warfare "conditions at home are unbearable."

The changed character of the migration is suggestive. Of the 200,000 who arrived in Dairen from Shantung and Chihli in March of this year, one quarter were women and children: in 1925 the percentage was seven. It is further suggestive that in spite of the very greatly reduced fares of the railroads and the concessions granted, only some 30 to 40 per cent travel by rail. The majority trudge along on foot the 435 miles from Dairen to Changchun. Inevitably much hardship is encountered. Governmental facilitation of immigration has been only of incidental importance and mainly opportunistic. The present great need in Manchuria is for a directive official colonization policy. The presence of a labor supply and new lands alone do not ensure economic success.

A New Irrigation System in French Indo-China. The beginning of 1926 saw the opening of a new irrigation system to water about 230 square miles in Thanh-hoa, the most northerly and largest province of Annam. An idea of the general setting of the province may be gained from a recently published work of the Société de Géographie de Hanoi, "Inventaire général de l'Indochine, Part 1: Structure et géographie physique," by Commandant Dussault (Hanoi, 1926). A detailed description of the coastal lowland is given by E. Chassigneux in "La plaine et les irrigations de Thanh-hoa," in the May, 1927, number of the *Annales de Géographie.*

The western part of the province is occupied by a series of greatly dissected plateaus pertaining to the northern end of the Annamitic chain; eastward lies the plain with which we are here concerned. There is little to distinguish it from the adjacent country of Tonkin on the north: topography, people, habitations, and costumes all are similar. The chief distinction is climatic. The mean annual temperature and especially the winter temperature are higher in Thanh-hoa; the rainy season, September to November, is more pronounced; the months from February to August are drier; and, most important, the yearly variation is much greater than farther north. In 1911 the rainfall was 47 inches; in 1907 it was 109 inches. The light rains that characterize the latter part of the cold season in Tonkin and the storms of the beginning of the warm season may be much reduced in Thanh-hoa; at times in July and August a dry föhn wind prevails from the west or southwest, the "wind of Laos." When the winter high-pressure system over the Asiatic continent develops more rapidly than usual the rainy season proper may be prematurely curtailed. These fluctuations are a serious matter in view of the density of the agricultural population on the plain—about 900 to the square mile.

The whole of the coast of Indo-China has been uplifted in recent times. The Tonkin delta is largely due to that movement. The plain of Thanh-hoa is an excellent example of a coast of emergence. Where best developed the following sequence is seen starting from the west: higher lands rising from three or four to eight or ten meters; lower lands in places only .30 to .60 meters above sea level; shore ridges, three or four meters high; a low depression often unfit for cultivation and the domain of the water buffalo; another series of shore ridges terminating seaward in a cordon of dunes. The higher parts grow a rice crop harvested in November and in winter and spring "dry cultivations"—cotton, sugar cane, sweet potatoes, and the like; in the lower parts rice is grown as a June as well as a November crop.

It is to safeguard against the droughts which every three or four years imperil this intensive scheme of agriculture that the present irrigation scheme has been devised. It involves the impounding of waters of the Song Chu, the chief tributary of the Song Ma, and distribution over the southern part of the plain. It is expected that the increased yields will transform Thanh-hoa from a poor province to the status of an exporter. It is interesting to note that the cultivators will not pay directly for their water as is done in the Punjab. In the latter case irrigation is practiced in an arid country, where water is the only real wealth. Indo-China is a humid country and the benefits of regularizing the water supply are less obvious; the tax will be levied on property.

Explorations in Sinai. Did not Sinai dip southward to a point it would correspond very closely in area and shape to the five southern New England states. But although not large and although two historical highways—one connecting Egypt with southwestern Asia, the other the sea road through the Suez Canal and Red Sea from Europe to the Far East—run past it, until within the last decade Sinai has harbored a tract of almost unexplored country. Dr. D. G. Hogarth says of the central highlands that they constitute "the least-known and most forbidding" region in the Peninsula . . . "unmapped, ill-watered, sparsely roamed by veriest wastrels of the Arab race. During the late War it was our blindest spot in the Near East."

These words are found in Dr. Hogarth's introduction to Mr. H. J. L. Beadnell's recent book, "The Wilderness of Sinai: A Record of Two Years' Recent Exploration" (London, 1927). Beadnell's journeys were carried out in 1921–1922 for the petroleum research program of the Geological Survey of Egypt. Their purpose was to fill in a broad gap intervening between the thoroughly mapped southern and northern zones of Sinai (compare "Mapping and Exploration in the Egyptian Deserts," *Geogr. Rev.*, Vol. 16, 1926, pp. 499–500).

Beadnell's straightforward account of his experiences is of particular interest to the geologist and physiographer. Excessive barrenness renders the physiographic features of Sinai remarkably prominent. As Hogarth asks, "Where outside the moon, do cosmic bones bleach so revealed?" Whereas the southern quarter of the peninsula is a confused tangle of crystalline mountains rising to an altitude of 8681 feet in Jebel Musa—the reputed Mountain of the Law—the main relief features of the central portion are two great plateaus, one superimposed above the other and each falling off on the southeast, south, and southwest in a mighty wall of cliffs. From the rims of these plateaus both underlying strata and surface dip generally northward, causing the run-off of most of the interior of Sinai to be carried to the Mediterranean. The maximum altitude of the southern edge of the higher plateau is 5338 feet. Evidence of extensive tilting, warping, and folding may be seen east and west of the central core of the peninsula and leads Beadnell to the conclusion that "the whole of the great low-lying basin occupied by the Gulf of Suez and the Maritime Plain is either a foundered tract or an area which has failed to participate in the general upward movement of the crust." This conclusion therefore supports Professor J. W. Gregory's theory that the Gulf of Suez forms a branch of the Great Rift Valley which is said to extend from northern Palestine to southeastern Africa and of which the Red Sea trough is supposed to form a portion. (See also: H. Sadek: A Scientific Study of Scenery in Sinai, *Compte rendu Congr. Internatl. de Geogr.*, Cairo, 1925, Vol. 3, pp. 144–154.)

The final chapter of Beadnell's book recounts briefly a visit to southern Sinai, to the famous convent of St. Katharine and the wild mountains around it. Calling attention to the interminable disputes among scholars regarding the route of the

Exodus and identification of the mount where Moses received the tablets, Beadnell wisely refrains from expressing an opinion of his own. It may be pointed out in this connection that a new theory based on a detailed comparison of local topography and place names with the biblical stories has recently been set forth by Professor Alois Musil in the appendixes to his volume "The Northern Heǧâz" published by the American Geographical Society in 1926. Musil locates Mt. Sinai on the mainland of Arabia southeast of the entrance of the Gulf of ʻAqaba.

The Production of Potash from the Dead Sea. The composition of the waters of the Dead Sea has long been a matter of academic interest. Recently, largely as a result of the opportunities created by the war, it has taken on a practical aspect. The Germans gave the possibilities of exploitation some thought in 1917 (Hermann Schroetter: Das Tote Meer, Vienna and Leipzig, 1924). British investigators followed, and it became a problem for the Government of Palestine under the Mandate. The proposal to grant a concession to British chemical interests for exploitation of the mineral resources is now reported in the press (*The Times Weekly Edition*, London, Aug. 18, 1927). An idea of the technical basis of the proposed industry may be gained from the series of investigations, dated 1923–1925 and entitled "Production of Minerals from the Waters of the Dead Sea," published on behalf of the Government of Palestine by the Crown Agents for the Colonies. In the summary of conclusions it is stated that "from the technical standpoint, as distinguished from the commercial, no insuperable difficulties are likely to be met with in connection with the extraction of potash from the Dead Sea in quantities of the order of 100,000 tons of potassium chloride per annum," and that "practically unlimited quantities of common salt and magnesium chloride could be produced."

The salts can be extracted by natural evaporation. Summer temperatures in the Dead Sea depression are high: the Dead Sea Post, at the northern end of the Sea registers summer temperatures of 105° F., and water temperatures of 60° C. are known: evaporation from April to September is estimated at nearly two meters. While the surface waters vary in salinity from place to place and from season to season, at a depth of 200 meters salinity is fairly constant. A suitable flat surface for evaporating tanks is found at the Dead Sea Post. This site too seems to be the most healthful available. The intense and stifling heat of the Jordan valley is here mitigated by a breeze which springs up from the Sea daily at 9 a. m. The site can be rendered free of malaria with not much difficulty, an important matter, for the Malaria Commission reports that without proper precautions for control the Dead Sea depression would prove to be one of the most malarious parts of the country. The Dead Sea Post, the only settlement, at present consists of some dozen houses whose inhabitants are occupied in the transportation of cattle and grain from the Transjordania side of the Sea. A few Bedouin from Gaza and Beersheba come into the region with their camels in winter. Labor could be recruited in part from Palestinian Arabs, and it is suggested that Jewish labor might be imported from Europe at wages which would include "an allowance for the cost of living at the Dead Sea."

The cost of transportation and the competition of the European product are beyond the scope of the report but are not less important than the technical considerations.

OCEANS

Recent Work on Iceberg Drift and Control in the North Atlantic. The scientific work of the International Ice Patrol continues to grow in interest and importance. The report for 1926 recently published (International Ice Observations and Ice Patrol Service in the North Atlantic Ocean, Season of 1926, *U. S. Coast Guard Bull. No. 15*, 1927) points out two major practical problems towards the solution of which many data are being gathered—the forecasting of the number of bergs and their course on arrival at the critical area about the tail of the Grand Banks. The number of bergs varies greatly from year to year: in 1912 approximately 1200 bergs were reported south of Newfoundland; in 1924 only 11. Wind seems to be the most important factor governing the southward drift of polar ice and the Patrol has found the most valuable forecasts to lie in the pressure differences between Belle Isle, Newfoundland, and Ivigtut, Greenland, during the period from December to March. Value also attaches to the pressure differences between Bergen, Norway, and Stykkisholm, western Iceland, for October to January. The pressure difference directly affects the amount of field ice which, acting as a fender along the shoreward side of the Labrador Current and preventing the stranding of the bergs, in turn affects the numbers of bergs that reach the critical area. The unusual absence of field ice in 1924, for instance, left the season's crop of bergs stranded in northern waters.

The courses of the bergs in the critical area may be predicted from a current map, for the movement of the bergs is controlled almost entirely by the subsurface ocean currents. The method of mapping is found in the dynamic conception of oceanography that has its basis in the studies of the elder Bjerknes and their applications by other Scandinavian scientists. It consists essentially of the establishment of isobaric surfaces in the sea by observations of temperature and salinity (Edward H. Smith: A Practical Method for Determining Ocean Currents; *U. S. Coast Guard Bull. No. 14*, 1925. See also Mr. Smith's report in the Trans. of the Amer. Geophysical Union for 1927, *Bull. Natl. Research Council No. 61*, July, 1927, pp. 212–217). These are taken at depths of 0, 25, 50, 125, 250, 450, 750, and 1200 meters at stations 20 to 30 miles apart along five lines at right angles to and seaward of the slopes of the Grand Banks. The entire series can be taken in a few days and a map constructed for an area of many thousands of square miles.

Other work by the Ice Patrol of special interest to geographers is the use of the sonic depth finder. In 1926 no less than 465 soundings were made in the region of the Grand Banks. In connection with this a chart has been constructed showing by zones the velocity of sound in the waters of the region after corrections have been made for pressure, temperature, and salinity (see also the tables by Commander N. H. Heck and Ensign J. H. Service, "Velocity of Sound in Sea Water," *U. S. Coast and Geodetic Survey Special Publ. No. 108*, 1924).

The possibility of reducing the ice menace by destruction of the ice itself has long engaged the attention of Professor Howard T. Barnes of McGill University, who has conducted investigations on ice and icebergs from the St. Lawrence River to Hudson Bay. In 1924 while accompanying one of the trips of the Ice Patrol he was able to obtain much valuable information on the natural dissolution of bergs. Observations showed that the greatest amount of cracking and calving took place at and immediately after sunrise. During the night when the surface froze over, and during the day when it ran with water and the surface temperature was steadily maintained at 0° C., conditions were comparatively stable. This suggested that "strains could be set up at will in the great ice mass by the local application of heat at a high enough temperature to cast powerful rays into the ice." (H. T. Barnes: Some Physical Properties of Icebergs and a Method for Their Destruction, *Proc. Royal Soc. of London, Ser. A: Math. and Phys. Sci.*, Vol. 114, pp. 161–168. See also *idem:* Experimenting with Icebergs, *The Marine Observer*, Vol. 4, 1927, pp. 93–98). A suitable agent was found in thermit (a mixture of powdered aluminium and ferric oxide). This was tried out on an ice jam in the Allegheny River in the winter of 1925–1926 (Engineering Features in Breaking the Allegheny Ice Gorge, *Journ. Engineering Inst. of Canada*, Vol. 9, 1926, pp. 453–461). The following spring Dr. Barnes carried his experimentation to the Twillingate Islands in Notre Dame Bay, Newfoundland, into which drift icebergs in great numbers and of all sizes. Thermit charges were exploded on three bergs with satisfactory results, encouraging the pursuit of further study in this direction.

HUMAN GEOGRAPHY

Migrations and the Spread of Disease. "One of the great achievements of modern civilization has been to prevent the transmission from country to country of communicable diseases," says Dr. Victor G. Heiser in a paper "The Health Work of the League of Nations" (*Proc. Amer. Philos. Soc.*, Philadelphia, Vol. 65, 1926, No. 5, Suppl., pp. 1–9). There has been a strong compelling motive to this achievement, for modern civilization by developing communications between peoples has itself opened the way to the easy and rapid spread of the bad as well as the good. A striking illustration is given by Sir Leonard Rogers in "The Forecasting and Control of Cholera Epidemics in India" (*Journ. Royal Soc. of Arts.*, Vol. 75, 1927, pp. 322–355). During the nineteenth century six great pandemics of cholera spread from India to Europe, five of them reaching America. The chief route lay through the Punjab and Afghanistan. The pandemic of 1826–1837 took five years to travel from India to southern Russia; that of 1892, five months. "This may happen again at any time if nothing is done to control the spread in India itself, where severe epidemics continue to occur at irregular intervals, the causation of which has not hitherto been worked out," continues Sir Leonard. His own investigations have led him to what he believes is the climatological key to the problem, absolute humidity.

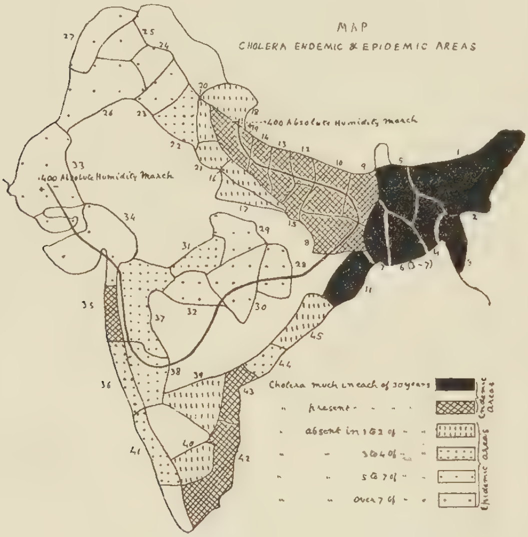

FIG. 1—Map showing cholera endemic and epidemic areas of British India, reproduced from Figure 8 of Sir Leonard Rogers' paper. Cholera is endemic in the areas shown in black and cross ruling, severer in the former; lighter tints show epidemic areas. The map also shows the .400 Absolute Humidity line for March. (Numbers on the map refer to provinces and districts.) The scale is about 1:40,000,000.

The critical value of absolute humidity (expressed as vapor tension in terms of mercury) appears to be .400, values below this being unfavorable to cholera incidence. Instead of a single endemic foyer, in India, i.e. Bengal, Sir Leonard concludes that there are three: Assam-Bengal-Bihar and Orissa and United Provinces, southeastern Madras Presidency, and a smaller area in the coastal region about Bombay. There is a recrudescence in these endemic areas with rising absolute humidity where it has been temporarily suppressed by low degree in the winter months. Increased incidence in the endemic areas is favored by deficient autumn and spring rainfall. Over the climatic factors themselves we have no control, though they can be forecast and the populace thus warned. Control, however, can be exercised over one of the chief factors in epidemics—human migration.

It is estimated that some twenty millions of people in India take part in the larger fairs and pilgrimages every year. The opportunities for infection at such gatherings are well known. Katherine Mayo's description of Benares in "Mother India" (1927) portrays vividly the difficulties of the health officer in that country. Disease is incurred not only at the gatherings but as the travelers pass through regions of endemic disease on their way. Cholera incidence in the Punjab is clearly related to the fairs at Hardwar on the upper Ganges. "From 1899 to 1922 every year in which cholera in the Punjab rose to .40 or more per mille the importation of the disease was traced to Hardwar pilgrims." The large Kumbh Hardwar fairs held every twelve years are attended by between one and two million people. Since 1867 each fair has been followed by serious outbreaks except in 1891, a year when absolute humidity conditions were distinctly unfavorable. A sanitary report on the Central Provinces in 1913 says "only four times in the last 45 years has the province escaped cholera, and in the vast majority of cases these outbreaks have been traceable to fairs, e.g. epidemics have been traced 15 times (chiefly in recent years) to Jaganath Puri, 8 times to Allahabad, 6 times to Pandarpur and 13 times . . . to small provincial fairs." Anti-cholera inoculation is the remedy suggested.

The subject of pilgrimages cannot be passed over without reference to Mecca. The pilgrimage of this year (1927) is reported to be the largest on record as far as overseas pilgrims are concerned, the number being estimated at about 130,000. (The progress of the pilgrimage may be followed in contemporay numbers of *The Near East and India.*) Their health is safeguarded by the quarantine stations on two islands about seven miles south of the port of Jidda. The stations are under the medical department of the government of the Hejaz and are reported to be excellently equipped. Pilgrims from the Netherlands East Indies, who constituted 50 per cent of the 1927 attendance, and from India, 20 per cent, pass quarantine at Kamaran Island, at the southern end of the Red Sea. An "Agreement Between the United Kingdom and the Netherlands Regarding the Sanitary Control over Mecca Pilgrims at Kamaran Island," signed at Paris June 19, 1926 (Treaty Series No. 26, 1926), established most thorough-going provisions for the efficacious treatment of pilgrims. Under one of the clauses the government of India undertakes to communicate to the Far Eastern Epidemiological Bureau at Singapore information regarding cases of plague or cholera which have manifested themselves.

The Bureau at Singapore is an establishment of the League of Nations. Its locale is well chosen: "Not only does it form the 'gateway' for shipping to and from the Far East, but it lies at the very centre of maritime communications between ports of countries which, from an epidemiological point of view, are of world-wide importance. In short, the health conditions and quarantine arrangements at Singapore are matters of very considerable international concern" ("Prevalence of Epidemic Disease and Port Health Organisation and Procedure in the Far East," Report presented to the Health Committee of The League of Nations by F. Norman White (C. H. 130)). The Malaria Commission is another important activity of the Health Section of the League. After the war there was a great incidence of this widespread disease in Europe. The Commission undertook in 1924 a tour of investigation of those European countries directly affected by the war where the disease is endemic—the Balkans, Rumania, Russia, Italy (League of Nations Health Organisation: Report on the Tour of Investigation of the Malaria Commission in Certain European Countries in 1924 (C. H. 273), Geneva, 1925). The Commission stresses the fact that malaria is a social disease and that mass movements of the population are of prime importance—movements of troops, of refugees from war and famine, of agricultural workers. A later tour of investigation in Spain likewise emphasizes the migration factor, citing the cases of pepper cultivation and *transhumance* in Estremadura, the harvest in Andalusia, and especially rice cultivation in Valencia and the Ebro delta (See the summary "El paludismo y la lucha antipalúdica en España," *Iberica*, Vol. 27, 1927, pp. 2–6).

Another major project of the League deals with Central Africa's problem of sleeping sickness. The League's interest led to an International Conference on Sleeping Sickness in London in 1925, at which it was recommended that an international committee be appointed by the League to deal with the matter. The case of other diseases also merits attention. In his report on "Labour in the Tanganyika Territory" (Colonial No. 19, 1926), Major G. St. J. Orde Browne says "Malaria and some other ailments are already fairly evenly distributed about the territory, but there are certain diseases such as hookworm and spirillum fever that are much more limited in occurrence, and these are being steadily spread by the present lack of system in travel control whereby previously uninfected tribes are exposed through the return home of labourers from areas of infection." He mentions two instances where labor is drawn from a distance of six to seven hundred miles, the journey being made on foot.

In a paper "L'organisme humain et le milieu biologique naturel," (*Bull. Soc. de Géogr. de Lille*, Vol. 68, 1926, pp. 105–113, 146–161) Maximilien Sorre of the University of Lille quotes several instructive instances of man's part in the spread of disease, among others the spread of sleeping sickness in the Congo as a result of the opening up of Africa. He concludes: "The progress of relations and especially the conquest of the world by Europeans beginning with the sixteenth century have contributed to aggravate the influence of the *milieu*, and without doubt it attained its maximum towards the end of the nineteenth century. But today, on the contrary, the progress of the biological sciences and their practical applications tend to limit it and to make for its progressive disappearance." In this note we have mentioned a few instances from one chapter of the new medical geography; the complexity of the whole subject of the reactions between man, his health and his environment M. Sorre shows well in his interesting and suggestive paper.

HISTORICAL GEOGRAPHY AND HISTORY OF GEOGRAPHY

Jodocus Hondius' World Map on Mercator's Projection, 1608. The small maps in the atlases of Mercator, Ortelius, Hondius, and Blaeu, of the famous Dutch school of cartographers of the late sixteenth and early seventeenth centuries, are fairly well represented in libraries and private collections, but the more perishable, large wall maps have become extremely rare. In 1919 the Royal Geographical Society acquired the only known copy of Jodocus Hondius' world map of 1608 on Mercator's projection. A collotype reproduction of this in twenty-five sections and an index sheet was published early this year. Specially made paper was used, and exceptional care was taken in every respect. The result is exquisitely clear and attractive. The reproduction is accompanied by a scholarly memoir by Mr. Edward Heawood, Librarian of the Royal Geographical Society.

Jodocus Hondius (or Josse Hondt, 1563–1612), as was customary in his time, had no scruples against borrowing ideas, or even copying without acknowledgment, from the works of predecessors. For the map of 1608 he used maps by Mercator as well as a world map of Petrus Plancius, 1592, of which the one copy now known has not as yet been reproduced. Heawood points out that "it is perhaps as a work of art that the map [of Hondius] . . . most claims our admiration. But in this field it had at least one predecessor of almost equal merit, Blaeu's big map of 1605, the influence of which is obvious." The latter was reproduced by the Hispanic Society of America in 1914, with accompanying text by Dr. E. L. Stevenson.

The rectangular panel of the map proper is surrounded by a series of circular and oval vignettes in which figures supposed to represent the natives of the various countries of the world alternate with plans and views of important towns. Oceans and unknown land on the map surface itself are covered with drawings: ships and marine monsters fill the seas; a magnificent group of allegorical figures personifying the continents occupies northern North America. A row of heads representing Ptolemy and the four circumnavigators, Columbus, Drake, Candish or Cavendish, and Van Noort, fringe the margin of the Austral continent. Below the head of Ptolemy is a small map showing what Hondius believed to be the range of the former's geographical knowledge, and below each of the circumnavigators is a similar small map representing his route.

A long disquisition on the geography of the world given below the map panel was copied almost word for word from Plancius. Legends are scattered here and there, many of which Heawood translates. One explains a graphic method, which Hondius claimed himself to have devised, for constructing cartographic grids on Mercator's projection; another gives a rule for measuring distances on maps drawn on Mercator's projection; another presents an argument on the superiority of Hondius' map over the average sea chart; and an exceptionally interesting passage deals with the winds of the Pacific Ocean.

Heawood asserts that, "as regards the general geographical details, Hondius shows no marked divergence from his contemporaries." The huge southern continent which figures so prominently on the maps of Mercator and others and persisted until the eighteenth century (see Armand Rainaud: Le continent austral, Paris, 1893) also bulks large on Hondius' map of 1608. On the other hand, the four fabulous islands which Mercator placed in the Arctic regions are not shown. Contemporary discoveries by Barents, Davis, and Hudson in their search for the Northwest and Northeast Passages, however, are indicated. Although Mercator's exaggerated longitudinal extension of Europe and Asia is considerably reduced, the length of the Mediterranean Sea is overestimated—an error dating back to Ptolemy—and, as a result, Italy is warped out of shape. China is represented in part on the basis of information acquired in the sixteenth century, but northeastern Asia still bears the traces of Marco Polo and Ptolemy in its place names. In North America the St. Lawrence is the principal river, but there is no sign of the Great Lakes.

A large world map on the stereographic projection by a certain Jodocus Hondius was reproduced under the joint auspices of the American Geographical Society and the Hispanic Society of America in 1907. Mr. Heawood suggests why the date, 1611, ascribed to this map by its editors, Dr. E. L. Stevenson and Father Joseph Fischer, S. J., is not altogether certain. The map may have been the work of the younger Hondius.

Some Recent Geographical Bibliographies, with a Special Reference to the History of Geography. Volumes 40 (1924–25) and 41 (1926) of the *Geographisches Jahrbuch*, edited by Dr. Hermann Wagner, have recently appeared. We wish here to call particular attention to the summary of recent progress in the field of history of geography since the middle ages by Professor Konrad Kretschmer of Charlottenburg. Students of the history of medieval and modern geography for some years have been hampered by the lack of recent bibliographical aids compiled to meet their special needs. Professor Kretschmer's review brings up to date the similar reviews by Sophus Ruge and Walter Ruge in earlier numbers of the *Jahrbuch*. After a section on the history of geography and cartography in general (in which, by the way, attention is called to the fact that no broad, general history of our science has been written since O. Peschel's work, published in 1877), subdivisions follow devoted to the early Middle Ages, the work of the Arabs and other Orientals, the Scholastic Period, the Period of the Great Discoveries, and the so-called "Age of Measurements" (*c.* 1650 on).

Another extremely useful aid to studies in the history of geography has likewise appeared within the last year: Dr. George Sarton's "Introduction to the History of Science, Vol. 1: From Homer to Omar Khayyam," *Carnegie Instn. Publ. No. 376*, Washington, 1927. As fortune would have it, this volume is in the main devoted to the ages before the period covered by Kretschmer. Sarton, envisaging science as a unit, endeavors to give a survey of its development throughout the whole world. His method seems somewhat peculiar at first sight. His conception of the subject is so broad, however, that the method is probably the best that could have been devised. In each chapter the author presents a cross section of the state of science in every civilized region at a particular time. Thus, if we read continuously, we constantly jump from Rome to Greece, from Greece to Mesopotamia, from Mesopotamia to India, from India to China, and occasionally we clear the entire stretch from the Western Mediterranean to the Far East in one leap. The first four chapters are devoted to the period between the ninth and the end of the fifth centuries before Christ; Chapters 5–34 cover a half century apiece. Each chapter opens with a general statement showing the relation of the contemporary developments both to one another and to previous growth. These introductory statements are very skillfully worked out and written with a light touch, refreshing in a work of such erudition. They serve as a corrective to what might otherwise seem an over-artificial chronological arrangement, and they make it possible for the specialist to gain some idea of the manner in which the evolution of the particular subject in which he is interested is related to broader movements. After each of these general summaries brief estimates are given of the developments in the various fields of science, and these, in turn, are followed by short sections on the work of individuals, with extensive bibliographical references. The bibliographies, indeed, are perhaps the most useful feature of the entire publication. Titles of texts, translations, and modern studies are listed, often with illuminating comments. In this connection Sarton has used much of the material that he has been incorporating in the critical bibliographies of the periodical *Isis*, founded by him in 1912 and now the organ of the History of Science Society.

If space permitted, one would be tempted to discuss at length some of the many points of unexpected interest brought out in Sarton's volume. For instance, in the section devoted to the first half of the tenth century, a time when science in Christendom was at a very low ebb, no less than eleven oriental geographers (ten Moslem and one Chinese) are listed. The quantity and quality of geographical work done by the Chinese from very early times is a revelation. Thus, at the end of the eighth century after Christ, Chia Tan drew a "Map of China and of the Barbaric Countries Within the Seas." Sarton believes this to have been the first large-scale map of an extensive area ever constructed. "It was 30 feet long and 33 feet high and on a scale of one inch to one hundred li" (about one inch to twenty miles).

GEOGRAPHICAL NEWS

"Antiquity": A Quarterly Review of Archæology. The first number of the new magazine *Antiquity* appeared in March of this year, under the editorship of Mr. O. G. S. Crawford, Archæology Officer of the Ordnance Survey of Great Britain. The magazine aims "to summarize and criticize the work of those who are recreating the past" and this on a broad basis not confined "too rigidly within the conventional limits" for "the past often lives on in the present." The aim has been well filled in the two numbers already issued.

The March number opens with an article by the editor on "Lyonesse," the legendary land between the Scilly Islands and Cornwall, of interest to the student of coastal changes. Among other papers in the number are "Orientation," by Vice-Admiral Boyle-Sommerville; "Maori Hill-Forts," by Raymond Firth; and "The Danube Thoroughfare and the Beginnings of Civilization in Europe," by V. Gordon Childe. The volume for June includes "Where did Man Originate?" by E. A. Hooton; "Place-names and Archaeology," by A. Mawer; "The Etruscans," by D. Randall MacIver; "The 'Works of the Old Men' in Arabia," by Flight-Lieutenant Maitland; and "The Aryan Problem—Fifty Years Later," by A. H. Sayce.

OBITUARY

Eduard Brückner. The death of Eduard Brückner in Vienna, May 21, 1927, at the age of 65, means a severe loss to three sciences: geology, meteorology, and geography. One of Albrecht Penck's early students at Munich, Brückner contributed the first monograph published in Penck's *Geographische Abhandlungen:* a study of the glaciation of the Salzach region on the boundary between Bavaria and Austria. In 1888 Brückner became professor of geography at Bern; he held this position until 1904, going in that year to Halle and in 1906 to Vienna as Penck's successor in the chair of Physical Geography, which he occupied until his death.

Brückner's work was both original and precise. His outstanding contributions were in two main fields, meteorology and glacial geology. His well known discovery of a climatic cycle of thirty-five years within which warm, dry years alternate with cold, wet years was set forth in detail in 1890 in an elaborate monograph entitled "Klimaschwankungen seit 1700." Discussing the Brückner Cycle at a joint meeting of the Association of American Geographers and the American Meteorological Society in Philadelphia, December 30, 1926, Dr. Alfred J. Henry asserted that the "reality of the cycle has not been seriously questioned."

Brückner participated in the American Geographical Society's Transcontinental Excursion of 1912 and is remembered for his winning personality. In an article contributed to the Memorial Volume of the Excursion he endeavored to correlate the history of settlement in the western United States with climatic oscillations. Brückner's work in glaciology is also significant. He collaborated with Penck in the authorship of "Die Alpen in Eiszeitalter" (3 vols., 1909), the fundamental study of the advances and recessions of the Pleistocene ice in Europe, and in 1906 he founded the international journal, *Zeitschrift für Gletscherkunde.*

Sir HARRY HAMILTON JOHNSTON. Sir Harry Johnston died on July 31 at Woodsetts, near Worksop, England, in his sixty-ninth year. At the age of twenty-one in Tunisia he entered on the career that has left its mark on Africa. From that date until the beginning of the present century he was almost continuously in Africa. It was the time when the scramble for that continent was in full swing, and Sir Harry contributed his full share to the acquisition and maintenance of British territory. In 1882 he joined an expedition to Angola whence he proceeded alone to the Congo, there meeting Stanley. "The River Congo" was published in 1884, and he later made use of his own experiences as a background to "George Grenfell and the Congo" (1908). On his return to England he was invited to lead the Kilimanjaro Expedition of scientific and political import ("The Kilimanjaro Expedition," 1886). The next three years were spent in consular services on the Guinea Coast and then in Mozambique, which in turn led to Nyasaland and six years of excellent work as Commissioner and Consul General of that territory ("British Central Africa," 1897). After two years in Tunisia again Sir Harry was appointed Special Commissioner of Uganda. A splendid memorial to his versatile genius is to be found in the two volumes based on his experiences there, "The Uganda Protectorate (1904)," with a wealth of paintings, drawings, and photographs of birds, beasts, and people. It was during his stay in Uganda that he discovered the okapi. In 1899 "A History of the Colonization of Africa by Alien Races" was published; it became a standard work, and a revised edition appeared in 1913.

Sir Harry had pronounced sympathies with the natives; in fact the *Westminster Gazette* refers to him as "one of the greatest benefactors of the African races." This interest led him to visit the United States and the West Indies and record his observations in "The Negro in the New World" (1910). Undoubtedly the scientific work that lay nearest his heart was the "Comparative Study of the Bantu and Semi-Bantu Languages" (Vol. 1, 1919; Vol. 2, 1922), a monumental work of permanent value and a life task that he was happily enabled to complete. A list of his major writings is given in his entertaining and readable autobiography "The Story of My Life" (1923).

GEOGRAPHICAL REVIEWS

CIVIL AVIATION IN EUROPE

Grosser Luftverkehrs-atlas von Europa. Bearbeitet und herausgegeben unter Mitwirkung der Wissenschaftlichen Gesellschaft für Luftfahrt E. V. (WGL), Berlin, und unter Benutzung des Materials der Deutschen Luft Hansa A. G., Berlin. l and 202 pp.; maps, ills. Verlag für Börsen- und Finanzliteratur Aktiengesellschaft, Berlin and Leipzig, 1927. M. 25. 13 ½ x 9 ½ inches.

The Approach towards a System of Imperial Air Communications: Memorandum by the Secretary of State for Air, laid before the Imperial Conference, 1926, together with the Report of the Imperial Air Communications Special Sub-Committee. xiii and 91 pp.; maps, diagrs., ills. H. M. Stationery Office, London, 1926. 5s. 13 x 8 ½ inches.

The preliminary text of the "Luftverkehrs-atlas" reads not unlike a railway or steamship guide. After lists of airdromes and air routes there follows a comprehensive table of passenger fares and surcharges for baggage. Some of the fares converted into dollars, with flying times, are as follows: London to Paris, $25.50, 2 hrs. 30 mins.; Berlin to Munich, $25.00, 4 hrs. 15 mins.; Berlin to Moscow, $71.40, 12 hrs. 50 mins.; Stuttgart to Zürich, $8.30, 1 hr. 10 mins.; Toulouse to Dakar, French West Africa, $190.00, 47 hrs. 10 mins. Next comes a statement of the conditions under which passengers and freight may be transported, with explanations of the requisite tickets and passports. The companies assume no responsibility in case of accident, but passengers are insured by the Deutsches Luft Hansa without increase in fare. Customs regulations and rules governing the sending of letters and packages by air mail are given at length.

Detailed descriptions are provided of the airdromes and landing fields of Europe. In each case a short article, something in the style of Baedeker, tells about the nearest large town and its principal points of interest. Then data are furnished relating to the landing field: specific facts regarding its ownership and control, its topographical position, its altitude, its geographical coördinates, its means of communication with the neighboring town, its meteorological station, facilities for the accommodation of passengers at the field itself, addresses and telephone numbers of the nearest doctors and hospitals, and a table of the distances to various near-by points.

The entries concerning the meteorological stations suggest the high degree of efficiency to which this service has been developed. To nearly every German airdrome one or more trained meteorologists are assigned. Local observers, for the most part postal employees, stationed at intervals of 50–100 kilometers along the air routes, send in telegraphic reports on weather conditions about an hour before the start of each flight. In addition, emergency observers give warning of the unexpected appearance of storms, fog, or other adverse conditions. Through the information thus gathered the meteorologists at the airdromes are able to furnish definite local forecasts and, if necessary, to recommend different routings. (See Harry Paech: Der deutsche Luftverkehr, *Petermanns Mitt.*, Vol. 73, 1927, pp. 13–18, reference on pp. 16–17.)

The maps are of two sorts, general and local. The general maps, on a small scale (mostly 1:1,000,000), show the air routes on which regular service is provided. In addition, numerous features of special interest to the aviator are indicated: the positions of airdromes and landing fields, radio stations with masts over 70 meters high, lighthouses, lightships, danger zones (particularly artillery practice or proving grounds, and balloon or kite stations), and areas prohibited for military reasons. The local maps, on a scale of 1:75,000, indicate the positions of landing fields in relation to cities. There is hardly a German town of any considerable size that does not have its field. German municipal authorities are eager to bring air service to their cities, as they wish to avoid a grave mistake made by some of their predecessors. The latter "when railways were first built frequently would have nothing to do with them. The evil resulting from this short-sighted policy was felt at a later date and, indeed, is evident in places even today, since many cities can now be reached only by branch lines, while the world's commerce passes by, far from their walls" (Paech, *op. cit.*, pp. 15–16).

The "Luftverkehrs-atlas" shows us something of the way in which the Germans, lacking colonial possessions, have constructed a closely meshed, highly organized network of air routes within their home country. British interest is primarily concerned, rather, with the development of long-distance airplane and airship communications throughout the Empire. This is made evident by the Air Ministry's document cited above. Here, among clear, non-technical discussions of widely varying phases of peace time aviation both as it has grown in the past and as it may be expected to evolve in the near future, may be found much of geographical interest, particularly regarding problems of navigation, instruments, aerial surveys, and the adaptations of routes to broad, permanent climatic as well as to local, temporary meteorological conditions.

Sir Samuel Hoare, Secretary of State for Air, asserts in his Memorandum that aviation "is one of the most effective instruments for stopping the waste of time that is now undermining the vitality and retarding the development of Empire intercourse." Regular service is contemplated in the near future between Cairo and Karachi in northwestern India, as the first link in a future air route that will join with England, Australia and the other far eastern parts of the Empire. Similarly, an experimental service between Khartoum and Kisumu in Kenya Colony is planned as the first link in a Cape-to-Cairo route. These projected main trunk lines will be fed by branches from neighboring colonies. Among the many interesting maps in the Memorandum reference may be made to one of the "England-India Airship Route showing meteorological stations from which observations are circulated daily, and high land which airships will normally avoid."

There is no doubt that aviation is rapidly becoming recognized in Europe as one of the well-established elements in the mechanism of transport and communication. Increasing public confidence is indicated by the fact that insurance charges are much less when freight is shipped by air than by rail or steamer. Despite the splendid work of our Air Mail, aviation in the United States has not reached this advanced stage. A partial explanation may be found in our failure to encourage aeronautic enterprise by government subsidies.

METEOROLOGY IN HISTORY

SIR NAPIER SHAW. **Manual of Meteorology, Vol. 1: Meteorology in History.** xx and 339 pp.; maps, diagrs., ills., bibliogr., index. The University Press, Cambridge, 1926. 30s. 10½ x 7½ inches.

This admirable manual by Sir Napier is growing backwards but growing so well that we are impatient to see the complete work. It is to be in four volumes, and the final proof of Part IV was given to the press on Armistice Day and soon published, while Part I has but recently appeared. Parts II and III are promised for the early future.

Meteorology, in the sense of a study of the weather, developed more or less independently with many savage races in the forms of imitative magic and earnest prayers, designed to control the weather or obtain the kind desired. Progressive culture eliminated the medicine man, but the weather went on. Then it was realized that while the storm could neither be coaxed nor scared, nor rains had for the asking, there are forerunners—signs, they called them—that give evidence of what to expect during the next few hours. Elijah told Ahab to hurry and eat and get down from Mt. Carmel "for there is a sound of abundance of rain." And thus in every part of the civilized world

"Men judge by the complexion of the sky
The state and inclination of the day."

This is an important phase of meteorology and deserves more intelligent attention than commonly is given to it.

Sir Napier's first volume takes us from the earliest known comments on the weather down through the heyday of weather signs, to the beginning of coöperative, or map, meteorology, in which forecasting the weather for one place is based on telegraphed reports of the existing weather at other places. Here and there, however, to complete a topic, something of more recent observations and theories is introduced. Thus, an excellent summary is given at the outset of the climate today of all those portions of the world known to the ancients, exclusive of China. This enables us better to understand classical allusions to the climate and the seasons and to judge whether or not marked changes have occurred in the climates of these regions within historic times. Sir Napier does not decide this question for us but gives several interesting quotations, pro and con, and leaves us to decide for ourselves, though intimating that the evidence suggests that on the whole the climatic changes within historic times have been only minor fluctuations of short duration.

In discussing the history of a science it is difficult to know where to stop, because it somehow ties up with everything else; and so, under the topic "meteorology" Sir Napier has given us an account of the calendar and the measuring of time. These are not strictly weather subjects, perhaps, but their inclusion is justifiable; and besides they are discussed exceedingly well.

An excellent account of the state of meteorological knowledge in the classical days of Greece is given by comments on and quotations from the works of Aristotle and Theophrastus. In the main this may also be regarded as a summary of the state of meteorological knowledge for more than 2000 years—the twenty centuries and more during which this and every other science was regarded as fully explained by Aristotle, when to quote him was to silence discussion and inquiry, and to doubt him intellectual sacrilege.

The longest chapter in the book gives brief biographical accounts of the seventy-four scientists who previous to the introduction of the weather map had added most to our knowledge of the air and its ways. Two of these, Francis Bacon and Galileo, made their contributions before the invention of the barometer. Only five were Americans—Franklin, Espy, Maury, Loomis, and Ferrel. One of the two full-page group pictures of international meteorological conferences shows only two Americans, Rotch and Page, neither connected with the official meteorological service; in the other, America is without representation. These facts are not flattering, nor is the situation improving. Meteorology, except the kindergarten variety, is practically ignored by our educational institutions. In professing to teach meteorology without a good previous knowledge of mathematics and physics, as so many do, they put themselves, in this respect, in the same class as that much-advertised electrical school that pretends to make of "anyone" a master electrician in a few weeks without books and without lessons!

Two interesting chapters are devoted to the weather elements, and methods of recording them, of the lower and the upper air respectively. Each of these topics, especially the latter, is very modern; yet it has a history, and that is given, but with practically no reference to the physical problems involved—that important part being left for the other volumes. The chapter on the upper air contains seventy-six small, but happily selected and excellently reproduced, cloud pictures.

The more difficult and less common measurements, those that involve the refinements, care, and accuracy of the laboratory, are listed in a separate chapter. These include the measurements of solar radiation, integrally and part by part; terrestrial radiation; atmospheric absorption and visibility; dustiness; lightning; and the electric and magnetic fields of the earth. Here too, as elsewhere, there are no instructions that would guide the observer, no detailed description of the apparatus, nor discussion of the problems these instruments help us to solve; they are without the scope of this volume. The various methods of representing meteorological and climatological data numerically and by charts and graphs are briefly discussed, sufficiently for the general student. The needs of the specialist cannot be provided in a book; he must consult monographs and a library.

In short, this first volume is essentially a history of meteorology, in which properly the science appears only incidentally, and then with but little allusion to physics and practically no use of mathematics. It therefore can be read by almost every "meteorologist," and should be. It would be vastly more to the point, however, if they, especially the "teachers" of meteorology, also could read understandingly every page of the other volumes, for they will treat of the science—a science but little known, unfortunately, to many that profess it.

W. J. Humphreys

The Problem of Civilization

Ellsworth Huntington. **The Pulse of Progress, Including a Sketch of Jewish History.** vi and 341 pp.; maps, diagrs., bibliogr., index. Charles Scribner's Sons, New York, 1926. $5.00. 9½ x 6½ inches.

Readers of the *Review* are so familiar with the work of Ellsworth Huntington that a new book by him calls for no introductory comment. It needs but be stated that in this, his latest work, we are promised a summary of the most important principles advocated in his previous writing; and, while this is true, the reader need not expect a mere restatement of old materials, for, on the contrary, the author illustrates these principles by putting them to new and, in some respects, novel tests. It is well, however, to note that the keynote of the book is to "show how the workings of these factors are connected with one another and with cultural changes; and third, to discuss a few examples which show how physical environment, biological inheritance, and cultural progress have worked together to produce the fluctuations of history" (p. 2). But this is not the whole story, for the work is so planned as to be a non-technical and readable presentation of the subject.

Turning now to the body of the book, we are introduced to the discussion by a preliminary orientation in the growth of culture groups, which are said to rise and fall, or to progress from inception to full vigor, and then decline to extinction. The author characterizes these phenomena as pulsations, though not periodically rhythmic. It is the irregularity of these pulsations that urges him to seek environmental causes and to look, first of all, for climatic shifts affecting the food supply.

After pointing out a suggestive correlation between periods of drought and economic cycles, the author checks the distribution of distinguished men against the distribution of land values, finding that the productive regions attract the ablest elements in the population. Involved in this is the question of migration, and the biological origin of these distinguished men is analyzed, the outcome suggesting that the ablest elements of the population tend to segregate in the most favored localities. Cities are then reviewed as indices of ability and wealth. Space does not permit enumerating all the points brought out in these first chapters, which are, for the most part, specific inquiries in selective migration within the United States and a study of nomadism in the Old World as a sifter of abilities and a developer of aggressiveness.

The author turns next to problems of climate, one chapter being contributed by Dr. G. C. Simpson, Director of the Meteorological Office. This section traverses ground covered in the author's earlier work but is given here in more concise form and in the clarified judgment that comes with time and reflection. The outcome is fairly put by the author, as showing that climatic changes and cycles are coincident with migrations of peoples and that there are observations, distinct from his own assumptions that one is the cause of the other. The discussion is rounded out by a résumé of the author's earlier conclusions as to the origin of race individuality, concluding that the initial causes are biological. On the other hand, the causes that disturb the stability of peoples, that sort out various grades of ability and temperament, are regarded as climatic and geographical.

The latter half of the book contains a novel and interesting study of the Jews, the historical materials being taken, for the most part, from the Bible and then correlated with geographical and climatic data for their habitat. In one sense, this is an ecological study, but what is most in evidence is an attempt to state the history of the Jews in terms of geography, climate, and the principles of interpretation developed in the first half of the book. To the naïve reader, this sort of treatment of the Bible, as the explanation of the successive plagues in Egypt, the reasons why the faithful were so long reaching the Promised Land, and the final isolation that intensified and set the religious passion of that people, will be little short of amazing. The author's treatment is also eugenical, since he makes a strong case for the relatively large number of great men appearing at every crisis in the history of the Jews, as due to the isolation of the people and inter-family crossing.

Whether all the interpretations offered are correct or not is a minor matter—the writer puts these forward as suggestions; but his treatment of Jewish history is a stimulating example of how geography should go hand in hand with studies of culture. That this section of the book will be vigorously assailed, goes without saying. Anyone who even hints at an external determiner in culture and in history rouses the resentment, not only of the orthodox Jew and Christian, but of a large scientific and scholarly faction with whom the immutability and freedom of man's social behavior is a fundamental doctrine. To all such, these chapters will sound sacrilegious; yet, one great value of the book, as a whole, is its vigorous challenge to the fundamentalist in religion and the self-determinationist in culture.

The volume closes with a brief comment on Russia and a running discussion of the tropics and the subarctic as unlikely places for future civilizations. In this section, as indeed throughout the book, emphasis is laid upon the biological selection that goes along with shifts in population. Many data are cited to show that migration is not random sampling, but that the sample is weighted; under one set of conditions, the sample will be high grade, another time, low grade, etc. Almost everyone agrees to this, even those who deny there is any such thing as heredity.

In many ways this is one of the author's most forceful books and should be welcomed by the intelligent reader. Such a reader is sure to close it with new problems in mind, and that is about the best that can be had from a book. The critical will feel that the author pushes his inferences to the very limit of the data; but it is the reader's privilege to choose his own distance, as the author has intimated.

Clark Wissler

The Transcaucasus Region

Anton Büdel. Transkaukasien: Eine technische Geographie. 152 pp.; maps, bibliogr., index. *Petermanns Mitt. Ergänzungsheft No. 189*, 1926.

Of all the newer political divisions that have resulted from the war and the successive treaties that followed it, none is perhaps worse off from the standpoint of reliable statistical data than the Transcaucasus region. There had to be considered in the first instance, in 1919, the three republics of Georgia, Azerbaijan, and Armenia. The Armenian boundaries were indefinite, though provision had been made in the Treaty of Sèvres, eventually discarded, for a boundary between Armenia and Turkey to be drawn by President Woodrow Wilson. Direct negotiations between Turkey and Russia resulted in a new boundary (Treaty of Kars) farther north than the old one established in 1878 and valid until 1914. By this treaty Kars, Ardahan, and Artuin were restored to Turkey. When the Transcaucasus was overrun by the Red army in 1921 and the governments reorganized, three principal political divisions of Georgia, Azerbaijan, and Armenia were formed into a regional union of Soviet Socialist Republics. In addition, a number of autonomous governments were established, both in the Transcaucasus and in the Northern Caucasus, so-called, north of the Caucasus Mountains.

With all of these changes the statistical sources generally available give one no aid in arriving at a picture of the resources of the country, the distribution of people, and the outstanding economic and social problems of the time—hence the importance of Dr. Büdel's monograph. He has made of it a compendium of broad scope, not omitting to state even the technical facts of astronomical observation, triangulation, and survey upon which the maps of the region depend; nor the geodetic observations, the geology, and the minutest details of climate, hydrography, etc. With the physical bases of geography laid down, he proceeds to a description of population distribution and capacity, the colonization of the country, the forests, agriculture, grazing, horticulture, fisheries, industries, transport and commerce in a thoroughgoing manner and with his statistics grouped by present political divisions so that they are at last in flexible form. Though his maps and statistics relate to the Transcaucasus as of 1914 so far as the Turkish boundary is concerned, the details are classified according to districts so that combinations are easily made which permit one to derive whatever facts are desired for a political group that may be in question. The region has a wide diversity of physical conditions and resources, and at the present time it is minutely subdivided by political lines. From the geographical standpoint these lines are of limited importance.

In Dr. Büdel's table on pages 99–100 giving the amount and transport routes of the different commodities of the Transcaucasus he has supplied us with a picture of the whole commerce of the region that is most valuable. It is shown how small is trade between the Transcaucasus and Asia Minor in contrast with the significant exchanges between Persia and the Transcaucasus. To Persia sugar, petroleum, metals, textiles, and food products go in large quantities; and from Persia come rice, fruit, wool, carpets, and grain. Baku is a great center of exchange with central Asia. Through the port goes a great variety of products of Russian origin; and out of it are sent petroleum products, rice, metals, sugar, food products, tea, most of which have been transported to Baku from central Asia. The author has even given the hydrographic measurements in such limited detail as they exist of the principal streams of the region and calculates the amount of energy that may be derived therefrom and their value in irrigation and industry. There is a bibliography of 212 items.

Lawrence on Arabia

T. E. Lawrence. **Revolt in the Desert.** xvi and 335 pp.; maps, ills., index. George H. Doran Co., New York, 1927. $3.00. 9 x 6½ inches.

This is not the place to add to praises heaped by a host of literary reviewers upon this remarkable book. Our interest in it here is solely geographical. And "Revolt in the Desert" is indeed a work of no little geographical value, even though geography as such may have been far from its author's thoughts. His aim was to tell the story of the Arab rising, and he doubtless purposely omitted topographical explanations that might bore the reader. This, together with the small scale of the map, often makes it difficult to follow the movements of troops and tribes. In his dramatic marches and countermarches Lawrence crossed some tracts of virtually unknown country, but he gives us no precise details regarding them. Nor was he in the least interested in "scientific" systems of transliterating place and personal names; when the publisher pleaded that it might be well to spell the same name consistently, he wrote back: "I spell my names anyhow, to show what rot the systems are." This rather disarms criticism.

The geographical value of "Revolt in the Desert," therefore, springs not from any conscious effort on the part of the author. The Arab campaign was an extraordinary example of the successful adaptation of military strategy to the particular problem that had to be solved—in this case a problem preëminently geographical.

"The Arab war was geographical, and the Turkish Army an accident. Our aim was to seek the enemy's weakest material link and bear only on that till time made their whole length fail. Our largest resources, the Beduin on whom our war must be built, were unused to formal operations, but had assets of mobility, toughness, self-assurance, knowledge of the country, intelligent courage. With them dispersal was strength. Consequently we must extend our front to its maximum, to impose on the Turks the longest possible passive defence, since that was, materially, their most costly form of war. . . .

"We must not take Medina. The Turk was harmless there. In prison in Egypt he would cost us food and guards. We wanted him to stay at Medina, and every other distant place, in the largest numbers. Our ideal was to keep his railway just working, but only just, with the maximum of loss and discomfort. The factor of food would confine him to the railways, but he was welcome to the Hejaz Railway, and the Trans-Jordan railway, and the Palestine and Syrian railways for the duration of the war, so long as he gave us the other nine hundred and ninety-nine thousandths of the Arab world" (pp. 66–67).

It is not in its military bearings alone that "Revolt in the Desert" is of geographical value. The book is flooded with the lights and shades both of the Arabian landscape and of the Bedouin character. In short, sharp phrases Lawrence makes us know the type of man bred by the desert. Thus: "The Bedu were odd people. . . . Had the circumstances of their lives given them opportunity they would have been sheer sensualists. Their strength was the strength of men geographically beyond temptation: the poverty of Arabia made them simple, continent, enduring." With words of this sort Lawrence every now and again dips beneath the surface. A little like Doughty, he saw Arabia and the Arabs with the eye of a poet, and geography needs the insight of the poet no less than the method of the scientist.

North America and the Swedes

Helge Nelson. **Nordamerika: Natur, bygd och svenskbygd.** Vol. 1: **Allmän översikt: De stora dragen av Nordamerikas geografi.** 258 pp.; maps, ills.; Vol. 2: **Geografiska landskaps- och miljöskildringar,** pp. 259–526; maps, ills., bibliogr. A.-B. Magn. Bergvall, Stockholm, 1926. 7 kr., 50 öre a vol. 10 x 7 inches.

North America and the Swedes, as the title of the book might be rendered, is an admirable account of the physiography of North America north of the Rio Grande, with geographic landscapes always culminating in man, worked out for each region, or rather wrought into every part of the work.

Considering the limits of the book, it is astonishingly comprehensive, the Canadian portion being especially fresh and full. The author has written a larger book on Canada, "Canada nybyggarlandet" (Canada, settlers' country). The author's experience of the continent is a brief nine months' visit. Some of his social evaluations show this. It is questionable whether freedom of blacks to marry whites in northern states had anything to do with bringing negroes north of late years, and the "open secret" some one has told him that black children are apt to occur disconcertingly in distinguished southern families is simply malicious slander. The black man has odd attraction for Europeans. Witness the full-page picture—a fine one—of two Pullman porters!

Generally the illustrations are fine—the author's own numerous photographs well taken and most intelligently conceived. The occasional maps are clear and good. Some of them are familiar but not well credited to sources.

But the leading motive of the book is the Swedes in America. Swedish-American Societies and the Government shared in Mr. Nelson's expenses on the trip, and so he visited the Swedes in all their strongholds. He finds them useful, prosperous, and respected; becoming rapidly Americanized; losing their mother tongue as soon as the second generation is established in contact with neighbors. There is a note of regret in the record of this loss of Swedish culture, and the reader gets the impression that the recent campaigns for Americanization are unfortunate and regrettable in the author's eyes, though he makes no definite comment of the sort and is generous enough to admit admirable American influences on the Swedish immigrant.

Probably it is difficult for a Swedish-American Society to conceive that an America sprinkled with little Swedens, little Italies, little Russias, and little Germanies, each with its home-village dialect, costumes, customs, and superstitions, could not be the America that so attracts European immigrants today. America, rich and powerful, is the object of widespread envy because of its wealth and power, but it is rich and powerful only because it is one great people. It has freed Swedes and Germans and Russians, to some extent at least, from narrow village prejudices, especially from the prejudice or superstition that they were born and destined for a lowly place in society and a life of subordination and discomfort; it has taught them to want and expect comforts that few in Europe ever attain and has taught them to work for them, as Nelson's Swedish Americans confessed to him they had worked, harder than they ever dreamed of working in the old country. It shocks Old World people to talk of Americanizing them, but the masses that have been Americanized think otherwise.

MARK JEFFERSON

THE ORIGIN OF OUR CHIEF TEMPERATE ZONE CROPS

N. I. VAVILOV. **Studies on the Origin of Cultivated Plants.** 248 pp.; maps, ills. *Bull. of Applied Botany and Plant-Breeding*, Vol. 26, No. 2. Institut de Botanique Appliquée et d'Amélioration des Plantes, Leningrad, 1926. In Russian with English translation.

The author of this book has presented his material in a clear, concise, and stimulating manner. The conclusions reached are backed in every case by a convincing array of facts and are quite distinct from those of earlier investigators. Based on a detailed study of the anatomy of the plants, their genetic behavior, their cytology, their distribution, and their diseases, he has convincingly presented the case of the centers of origin being marked by diversity.

The soft wheats are recognized as having 67 botanical varieties. While the whole of Europe does not show more than 15 or 20 varieties, in Persia and Afghanistan alone there are 50 varieties. Soft wheats appear to have been introduced only lately into Africa. Club wheat has a distribution similar to soft wheat and originated like the latter in the mountains of Afghanistan and southwestern Himalaya. Durum wheat, on the other hand, shows little diversity in Asia and is absent from most of the districts of southwestern Asia. Abyssinia, Algeria, and Greece, on the contrary, show all the features of polymorphism of durum wheat. Thus there are two distinct centers of distribution of wheat, the soft wheats from Asia and the durum wheats from North Africa.

Barley shows two chief regions of diversity: Algeria, Tunis, Morocco, Tripolitania, Arabia, Mesopotamia, and to a less degree Afghanistan; a second area in racial diversity is southeastern Asia, China, Japan, and the region about Tibet. Oats, which de Candolle regarded as of European origin, were not cultivated by the Jews nor the Egyptians. Cultivated oats, however, originated from a weed or wild species whose center of origin is difficult to locate, for it is not certainly European and may be partly Asian. There is also a variety of oat which originated in Abyssinia, another which originated in North Africa and the Mediterranean region, and still another, a naked-grained variety, which is distinctly Chinese. Of the millets, the center of greatest diversity is in Eastern Asia.

A most interesting chapter deals with weeds as the progenitors of the cultivated plants and discusses chiefly rye and oats. One of the astonishing features of rye is its remarkable homogeneity. A brittle form of rye occurs wild in fields of wheat and barley in Turkestan and Afghanistan. Southwestern Asia is the center of the diversity of rye. This same region gave rise to the soft and cultivated wheats. Here rye occurs as a weed of the brittle type and is not cultivated in Syria, Palestine, India, or China. As you pass from lower elevations to higher elevations in Afghanistan Hindu-Kush, and Bukhara, the conditions become increasingly difficult for the, success of wheat and barley and increasingly favorable to rye. In these mixed fields rye increases from as low as 3 per cent of the crop at 400 meters, to 39 per cent of the crop at 2000 meters. The same condition obtains as we pass north and west. As the barley and wheat crops were pushed out to the colder and poorer area, first, winter barley dropped out in Transcaucasia, Turkestan, and Transcaspia; and farther north in Siberia, European Russia, and Germany wheat dropped out and left rye as a pure crop. On the border line of this struggle between wheat and rye mixed plantings are often made. If the season is favorable for rye, then rye predominates; if favorable for wheat, then wheat predominates. Rye has, therefore, become a cultivated crop by being a weed which could not be eliminated; and, when the crop fails as we go north, the weed has taken its place.

Many examples of a similar nature are cited; and such, the author believes, was the origin of many of the cultivated groups. Plants that are noxious weeds in the south become important food crops in the north. The author classifies crops into primary crops—ancient crops—such as wheat, barley, rice, soy beans, flax, and cotton; and secondary crops, which have originated from weeds, such as rye and oats.

It is difficult to trace the origin of the primary crops. Crops showing great diversity are often limited to very rich soils, to places near human abode. When food becomes scarce, these wild grains of the non-shattering type are collected within their natural area first for food and as this is repeated ultimately pass into cultivation. This introduction into cultivation is natural and often involuntary. Barley probably originated from the weed *Hordeum spontaneum*, a plant which occurs in cultivated or disturbed places in rich, loose soil, rather than from the barley which grows on dry slopes far from the habitats of man. Aegilops closely approaches the soft wheats and readily crosses with them. It grows as a weed in the fields of wheat and barley and may have given rise to the former. Wild oats likewise grows as a weed. We may therefore look for the progenitor of our cultivated plants not in those which are distinctly different in their ecological requirements but in those which are weedlike and require conditions similar to cultivation.

The great centers of distribution of cultivated crops seem always to have been mountainous regions. While the historian and archeologist have generally supposed the river basins to have been the home of ancient man and cultivated plants, an examination of the crop plants has shown the mountains to have been the regions which have originated the greatest diversity. Not only are the plants here greatly diversified but the races of man likewise. There may be some correlation between these two sets of distributions. The most important regions have been mountains adjacent to deserts where a great variety of conditions is to be found. Here are to be found protection, an abundance of water, and irrigation; and here, in all probability, primitive agriculture developed. The mountainous regions of the earth, which constitute a twentieth of its land area, support approximately nine hundred million people.

The great centers of distribution of cultivated plants recognized are:

(1) Southwestern Asia, India, southern Afghanistan, and the adjacent mountains of Bukhara, Kashmir, Persia, Asia Minor, and Transcaucasus. Here have originated the soft and club wheats, rye, small-seeded flax, small-grained peas, lentils, horse beans, vetchlings, chick-peas, and Asiatic cotton.
(2) Southeastern Asia, China, Japan, and Nepal. Here have originated naked oats, hull-less barley, millet, soy beans, many cruciferae, and many fruit trees.
(3) Mediterranean Egypt, Algiers, Tunis, Palestine, Syria, Greece, Spain, Italy, and western and southwestern Asia Minor. Here have originated durum wheats, Byzantine oats, large-seeded flax, large-grained pea, vetchlings, horse beans, lentils, beetroot, and many vegetables and fruit trees.
(4) North Africa, Abyssinia. Here were produced hull-less barley, violet-grained wheat, original races of peas, peculiar varieties of oats, and many endemic plants.
(5) New World, Mexico, and the mountains of Peru. Here were produced potatoes, Jerusalem artichokes, corn, beans, tobacco, the sunflower, American cotton, vegetables, and fruits.

A possible sixth center is indicated as the Philippines, where rice and Coix may have originated.

Although the author has not considered in this paper the origin of many important tropical crops, he has given us a most stimulating picture of the probable origin of our important temperate crops and has led the way to a method of discovering "the strongholds hiding the origin of species." These conclusions are based on extensive travel and personal study. He has, likewise, shown the importance of a scientific attack on the practical problems of the origin of new varieties of cultivated crops.

H. L. SHANTZ

VOLCANISM IN NEW ZEALAND

J. ALLEN THOMSON. **Volcanoes of the New Zealand-Tonga Volcanic Zone: A Record of Eruptions.** Ills., bibliogr. *New Zealand Journ. of Sci. and Technol.*, Vol. 8, 1926, pp. 354–371. Wellington.

J. A. BARTRUM. **White Island Volcano.** Ills. *Ibid.*, pp. 261–266.

From a little south of the middle of the north island of New Zealand, and extending for nearly 2000 miles in a north-northeasterly direction to the Tonga Islands, there is a line of volcanoes in various degrees of activity. These volcanoes lie on the summit or on the western slope of what appears to be a ridge of "continental rock," which slopes gently towards the west but descends steeply towards the east into the narrow Kermadec and Tonga Deeps. This ridge is an important tectonic feature. The volcanoes on it are composed almost entirely of andesitic rocks; whereas the volcanic rocks on the islands east of it are practically made up only of basaltic and related rocks. It has been suggested that the ridge extends 2500 miles farther to the Hawaiian Islands: but Thomson gives good reasons for disbelieving this; he thinks that it may bend to the northwest near the Tonga Islands and form the platform of the Ellice, Gilbert, and Marshall Islands. He also thinks that this ridge may represent the true western boundary of the Pacific Ocean in its neighborhood. I suppose Thomson may be pardoned for ascribing the ridge to a line of weakness and the volcanic activity to relief of pressure, these expressions are so common in geologic literature; but they are merely a sword to cut the Gordian knot which geologists and geophysicists have not been able to unravel.

All the volcanoes and solfataras are described, and an account is given of their activities so far as they are known. Few observations go back so much as 100 years; most are quite recent. What eruptions have occurred were explosive; and the different craters have erupted independently. Although sections of lava sheets can be seen in some craters, no lava flows have been certainly seen; but in some cases the red glow on the ejected steam indicates the presence of liquid lava in the crater. The Tarawera eruptions of 1886 are described; at that time some twenty-one new craters erupted along a line eight and three-quarters miles long. The fact that only fumarolic action had been seen here before this eruption leads Thomson to the conclusion that "hot springs, geysers, and steam jets are not necessarily signs of the waning activity of an expiring volcano, but may be signs of a rising lava-column in new ground."

The paper ends with a chronological list of known eruptions, which is recognized as incomplete, and with a bibliography.

Bartrum's paper, although published earlier, is really supplementary to Thomson's. It is a special description of White Island Volcano which rises in the Bay of Plenty on the north shore of New Zealand. The crater is breached on the eastern side but elsewhere is bounded by precipitous cliffs more than 1000 feet high. The floor of the crater is only about 40 feet above sea level; fumaroles exist in the floor and are more concentrated near its boundaries. There are considerable sulphur deposits which are being exploited. In 1914 a disaster killed all the operatives. Recently (1926) inaccurate newspaper reports led Jaggar to suggest that engulfment was taking place and that an approaching eruption was indicated. Bartrum examined the volcano especially with this idea in view. He concluded that the 1914 disaster was not due to an eruption but to landslides from the crater walls and a mud flow in the crater floor. Cracks exist in the walls, and some movement is going on. He fails to find evidence of any impending eruption.

HARRY FIELDING REID

THE CAUSES OF CLIMATIC CHANGE

C. E. P. BROOKS. **Climate through the Ages: A Study of the Climatic Factors and Their Variations.** 439 pp., maps, diagrs., bibliogr., index. Ernest Benn Ltd., London, 1926. 16s. 8½ x 6 inches.

"Climate through the Ages" is a companion volume to "The Evolution of Climate" by the same author. It is a treatment of the climates in the earth's history from the meteorological point of view.

The first part, "The Climatic Factors and Their Variation," is essentially a textbook in meteorology. The great climatic changes are held to have been due to the operation of a number of different factors acting in the same direction. The dominant factors have always been geographical—the word taken in a very wide sense including distribution of land and sea, ocean currents, vertical circulation of the ocean, general elevation of the land, and volcanic activity. Non-geographical factors—astronomical, solar—have had only minor effects. Changes in the solar activity influenced the melting of the Pleistocene ice sheets, as recorded by the varved clays, and have caused small climatic fluctuations during the past two thousand years.

The second part, "Geological Climates and Their Causes," is an application of the author's views on the climatic factors. It is inferred that the climates of the past can be tolerably well explained by the distribution of land and sea, mountain ranges, ocean currents, etc., without resort to drift of the continents in Wegener's sense.

The third part treats the climates of the historical past, from about 5000 B. C. till the present. It is based on data from all parts of the northern hemisphere, such as historical records, migration of peoples, growth in thickness of trees, variations in levels of lakes, and floods of the Nile. There were several distinct fluctuations, some embracing wide areas, others local in character.

The climatic factors are so numerous and their possible rôles and combinations so varying and many that the results of a study of the past climates, which have no correspondence or only partial correspondence in the existing climates, will be markedly influenced by the way of approach. The meteorological approach, employed in the present volume, naturally tends to lead to a possible explanation rather than to *the* explanation. Approach from actual knowledge of the climatic conditions during the late-glacial and postglacial ages would give another and probably truer valuation of the relative importance of the climatic factors. The halts in the retreat of the last ice sheets, caused essentially or entirely by low summer temperature, were largely independent of physiographic alterations. So, too, were the cessation of growth and the beginning of waning of the ice caps, and very probably even their beginning of growth, for northern Europe and North America held practically the same stand relative to sea level during the last interglacial epoch as they do today, and no other essential physiographic differences may have existed. The same also holds true for the postglacial climatic changes in Scandinavia and in North America. The late Quaternary climatic changes in the glaciated areas were thus not mainly due to geographic alterations. The relationship that existed was essentially reversed. Climate on the whole was cause, and physiographic changes were consequence. The chief relationship was: temperature rise, waning of the ice sheets, rise of the glaciated lands. The climatic changes at least during the latter part of the Quaternary may have been largely due to non-geographical factors, while the generally low temperature during the Quaternary epoch was due to geographic factors, primarily the mountain building in the Tertiary. The rôle in general of the geographical factors may be overestimated by Brooks.

However, different views on problems so little understood are but natural. The book is a bold and remarkable piece of work.

Ernst Antevs

Contributions to Hydrography and Maritime Meteorology

Köppen-Heft der Annalen der Hydrographie und Maritimen Meteorologie. 109 pp.; maps, diagrs., ills., bibliogr. Deutsche Seewarte. E. S. Mittler & Son, Berlin, 1926. 10½ x 7½ inches.

Twenty-one authors contribute timely articles on modern meteorology and climatology to this *Festschrift* to Dr. Wladimir Köppen on the occasion of his 80th birthday. Though the book has a strongly marine flavor, it comprises a wide sampling of modern meteorology by leading investigators.

A fine photograph of Dr. Köppen comes first, and an appropriate dedication. Dr. Köppen was born in St. Petersburg, son of an eminent Russian ethnographer, statistician, and antiquarian. Young Köppen's first scientific interest was botany, which he used so effectively later, in his classification of climates. In 1875 he went to the Deutsche Seewarte where he was first in charge of the weather service for four years, then more or less a free-lance investigator and, beginning in 1898, originator and director of the great aerological work of the Observatory. He was the first editor of the *Meteorologische Zeitschrift*. Among Köppen's almost countless published contributions, of which there have been as many as 108 in the past ten years, half of them climatology, the following are specially deserving of mention here: the daily period of wind velocity (Espy-Köppen), movement of barometric depressions, thunderstorms and squalls, clouds, his well-known beautiful wind charts of the oceans, his extraordinarily comprehensive classification of climates, and, recently, the studies of paleoclimatology in which he supports the revolutionary ideas of his son-in-law and colleague, Dr. Alfred Wegener.

Some of the discussions making up the Köppen-Heft may be briefly mentioned. Dr. E. van Everdingen (pp. 18–19) criticizes Dr. Hobbs' theory of stationary glacial anticyclones and shows that without the observed temporary displacements of the anticyclones precipitation would be inadequate for the maintenance of the ice caps. Five other papers touch problems of world weather or long-range forecasting. A. Defant presents numerical magnitudes for the atmospheric and oceanic exchanges from latitude to latitude (pp. 12–17). W. Grosse points to the elevation of annual mean temperatures in western Europe in recent decades, and, on the basis of progressive changes in the sequence of Brückner cycles, makes pentad forecasts of temperature and rainfall for Bremen (pp. 38–41, plate). Sir Napier Shaw urges the reservation of the term "centers of action" for those places where change of mass through the effect of convection (warming or cooling) takes place, e. g., Grand Banks and western Mediterranean in winter, rather than simply statistical highs and lows. Monthly maps of the North Atlantic showing differences between air and sea temperatures illustrate his point (pp. 85–88). A. Wallén describes his long-range forecasts of precipitation and lake levels in Sweden, based on the 28-month and 11.2-year cycles (pp. 89–92). L. Weickmann analyzes pressure waves over the northern hemisphere, particularly the circumpolar ones of 24 days (pp. 99–104, plate). Marine meteorology, aerology, and climatology are also well represented in this excellent collection—a fitting honor to a great meteorologist.

Charles F. Brooks

Colonial Ethnology In Relation to Native Policy

J. C. van Eerde. **Kolonial Volkenkunde, Eerste Stuk: Omgang met Inlanders** [Colonial Ethnology, Part I: Social Intercourse with Natives]. (Koninklijk Koloniaal Instituut te Amsterdam. Mededeeling No. 1. Afdeeling Volkenkunde No. 1.) 4th edit. ix and 181 pp.; ills., index. Amsterdam, 1926.

Professor van Eerde has given, not only to the Dutch but also to all colonizing countries, a very valuable book discussing the way we white people should behave towards the natives we have under our care. The number of reprintings (the book was first published in 1913 and last revised in 1926) indicates the great interest the Dutch public, especially those connected in some way with the colonies, take in these problems. In these days of unrest over all the Far East, in the days when the democratic countries are sometimes hesitant over their colonial policy—compare the American attitude toward the Philippine Islands—this presentation by one of the greatest of the Dutch ethnological experts has a particular value. Professor van Eerde gives not only his own point of view but shows how the Dutch government working along the same line is trying to improve the relations between whites and natives. The basis is mutual understanding, and the government asks from its officials a good knowledge of the native language and of the native ways of thinking. And so in his last chapter, Professor van Eerde dwells on the great importance of practical ethnology not only for the scientist but also for all those who work for better material understanding. It is regrettable that a book of this value has not yet been translated into English.

S. van Valkenburg

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ERRATA

p. 452, line 21: *for* Zulu *read* Sulu.
p. 662, footnote: *for* D. K. *read* K. D.
p. 695, line 19 from bottom: *for* Allen *read* Allan.

ADDITIONAL ERRATA IN VOLUME XVI

p. 474, line 1: *for* Kipping *read* Knipping.
p. 664, last 5 lines: The "new islands" referred to as reported by Nansen in "Spitsbergen Waters," 1915, p. 91, are Fearnley Islands and the Axel Heiberg Islands. They lie southward, not northward, of Nicholas II Land, their respective positions being 77° 15′ N. and 100° 45′ E., and 77° 35′ N. and 101° 30′ E. Hence the inference is invalid that they might represent the most northerly land in the world. Also, they were explored and their position determined by the Russian Hydrographical Expedition of 1914 (see *Geogr. Rev.*, Vol. 15, 1925, Pl. III).